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Nitrogen Fertilization in Relation to Parasitism of *Striga hermonthica* on *Sorghum vulgare*

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ABSTRACT. The effects of nitrogen fertilizers on the growth of *Sorghum vulgare* (Pers) and *Striga hermonthica* (Benth) were investigated in relation to parasitism. Addition of nitrogen fertilizers resulted in an increase in the growth of both infected and non-infected *Sorghum* plants. Application of either complete nutrient solutions or ammonium sulphate solutions to plants with split-root systems resulted in an increase in the growth of the root system which received high concentrations of the fertilizers compared to the other half of the root system which received only water. The shoot weights of the plants increased whether the fertilizer solution was added to one half of the root system or shared between the two halves, and also with or without infection. The number of *Striga* plants that emerged per pot was substantially reduced with increase of fertilizer especially by early application.

Measurements of the plant growth promoting substances as "gibberelic acid or kinetin equivalents" in the xylem exudates of *Sorghum vulgare* revealed an increase in the concentration of both growth substances whether the plant was infected or non-infected with *Striga hermonthica*. These findings together with the more vigorous growth of *Sorghum* plants and the suppression of the growth of the *Striga* plants with the addition of nitrogen fertilizers are discussed and the usefulness of nitrogen fertilizers for control of *Striga hermonthica* parasitism confirmed.

The family scrophulariaceae includes both facultative and obligate parasites and 26 genera are known to be root parasites. Among the obligate parasites, the genus *Striga* is well known as the most serious root parasite. The economical importance of this parasite is due to its ability to parasitize a wide range of cereal crops and more than 60 other plant species belonging to the family gramineae including sugar cane and many wild grasses. Moreover, parasitism on plants other than grasses has also been observed (Andrews 1947).

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The life history of the genus Striga is best known for *S. asiatica* described by Saunders (1933). Initially the seeds require an after repening period varying from a few month to several years depending on the range of temperature and humidity during storage. Also a pretreatment period of at least two weeks in presence of a stimulant exuded from young roots of host plants also are essential (Saunders 1933, Williams 1961a).

Vallance in 1950 reported that addition of the germination stimulant to pretreated *Striga* seeds increased their respiration rate and metabolism of proteins. The addition of germination stimulant to air dry seeds, on the other hand, increased metabolism of sugars but no germination occured. Williams 1961c, 1961b suggested that a kinin like substance which stimulated both germination and morphogenesis of *Striga* seedlings was present in the exudate.

Cook *et al.* in 1972 used ray crystallography to determine the structure of the stimulant and named it "Strigol". Mc-Alpine *et al.* (1976), Dolby and Hanson (1976) and Johnson *et al.* (1976) working independently prepared a variety of simpler compounds from the strigol structure. These chemical compounds were used to control the parasite by promotion of seed germination in the absence of host roots. The seedlings without a host eventually died. Ethylene also promotes germination of the parasite seeds (Eplee 1975).

The use of germination stimulants *e.g.* ethylene or strigol, for control of *Striga* parasitism was tried successfully in America. The use of these chemicals for control of *Striga* is too expensive for practical use by farmers. Chemical herbicides which can be used either before or after planting and supplemented by handweeding or hand weeding alone also can be very effective. Chemical herbicides and hand-weeding, when labour is available, also are expensive, however, chemicals such as nitrogen fertilizers are known to increase the growth of the host and also to suppress the growth and development of the parasite (Tarr 1961, Younis & Agabawi 1965). This has been attributed to the competitive effects between the host and *Striga* as a result of increased availability of nutrients. Generally, however, infection by *Striga* in poorer sandier soils is much more severe than in richer cultivateds soils (Wilson Jones 1953, Williams 1961c and Tarr 1961). In the U.S.A. rates as high as 200 and 400 kg/ha of nitrogen as ammonium nitrate completely suppressed *S. asiatica* in maize without harming the crop (Shaw *et al.* 1962). How nitrogenous fertilizers interfere with *Striga* parasitism is not known, however, in this paper attempts were made to study the effects of nitrogen fertilizers in relations to the paratism by *S. hermonthica*. Another objective of these studies was to examine changes in the growth promoting substances with activities similar to cytokinins and gibberellins in the xylem exudates from plants infected or non-infected with *S. hermonthica*. Further examinations of the mechanism by which nitrogenous fertilizers influence the effects of *S. hermonthica* infection on growth of the host plant and particularly on the growth promoting substances was also examined.

Experiment 1

Effects of nutrient application on the growth of *Sorghum vulgare* infected by *Striga hermonthica*

Procedure

Sorghum vulgare variety YE-90L seeds were sown in 8 cm square plastic pots in 50% sand and clay soil mixture. Soil in half the pots was infected with *Striga hermonthica* seeds (20 mg/pot) and an equal number of controls were non-infected. The pots were kept in a warm glass house (25°-30°C). The nutrient treatments were started one week after planting when the plants were thinned to 3 plants/pot. Fison's 211 soluble fertilizer was used as a source of nitrogen (composed of nitrogen 25.0%; phosphoric acid soluble in water (P_2O_5) 12.0%; potash (K_2O) 12.0%). 19.0 ml from this concentrate was diluted to 8.8 litres to make final concentration of 50 ug/ml nitrogen, 24 ug/ml P_2O_5 and 24 ug/ml (K_2O). This prepared Fison concentration is what recommended for use in glass house's experiments. From this Fison preparation 100 ml, 50 ml, 25 ml or 0 ml were used per pot. Enough distilled water was added so that all pots received a total of 100 ml. Treatments were given every week for 8 weeks with supplementary watering as required. Samples of 4 pots were taken at random from the infested and non-infested treatments at 4, 6, and 8 weeks after starting the nutrient treatments. Roots and shoots were seperated and their oven-dry weights were determined. The number of *S. hermonthica* seedlings growing on *S. vulgare* roots and emerging above the groundd were also recorded.

Experiment 2

Effects of nutrient application on split-root system on growth of *Striga* non-infected *S. vulgare*

Procedure

Sorghum vulgare seeds were grown in 12.5 cm square pots in clay soil for 3 weeks. The plants were washed free of soil and two uniform seedlings transplanted into paired 12.5 cm square pots with half of their adventitious roots on either side of the common edge of the paired pots. The paired pots were filled with well washed sand or vermiculite. Twenty four pairs of pots were prepared. The seedlings were left to recover for one week after which twelve pairs were randomly allocated to a treatment where one pot was given only water and the other half pair was given 100 ml of normal concentration of Fisson soluble liquid fertilizer. Both pots of the other twelve pairs were given 50 ml of the Fison nutrient solution. Nutrient solutions were given every week for 8 weeks. Four pairs of pots were harvested at 4, 6 and 8 weeks after the start of nutrient application. Root and shoot portions were seperated and oven dry weights were determined.

Experiment 3

Effects of application of ammonium sulphate to split-root of *S. vulgare* with and without *S. hermonthica* infestation

Procedure

Sorghum vulgare seedlings were transfered into paired pots for split-root use as described in experiment 2. Both pots, one pot or neither pot were infested with seeds of *S. hermonthica* (30 mg/pot). Seven nutrient treatments were applied every week starting on the 5*th* week after transplanting and continued up to the 13*th* week. Equal volumes (100 ml) of 200 ug/ml, 100 ug/ml, or 0 ug/ml ammonium sulphate were added to one or both pots so that each pair of pots had the same total nitrogen supply (Fig. 1). Samples of 4 pots were harvested at 4, 6 and 8 weeks after starting the treatments. Oven-dry weights of shoots and of half root systems were determined for each sampling data. The number of *S. hermonthica* seedlings parasatizing the plant roots either emerging above ground or remaining under the ground were recorded.

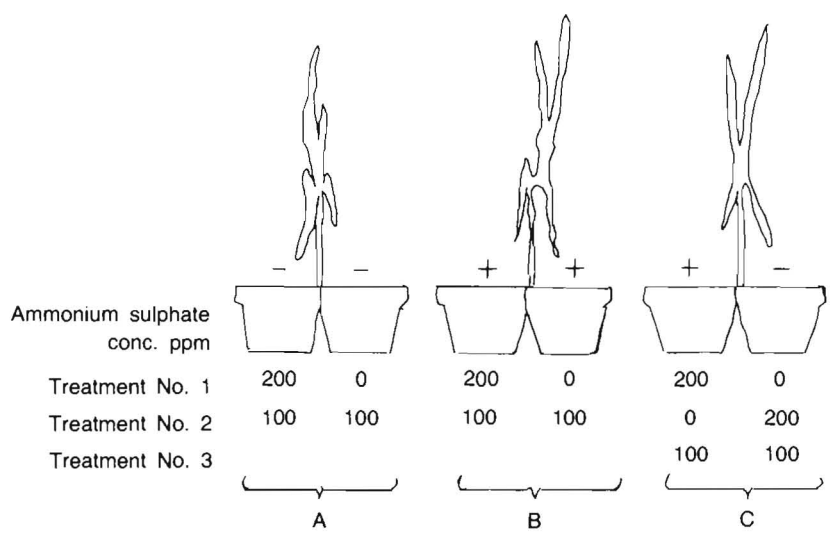

Fig. 1. Diagram showing distribution of *Striga* infection and fertilizer application on both halves of root systems of the same plant split between a pair of two firmly joined pots (−) non-infected by *Striga hermonthica*, (+) *Striga* infected half roots of *Sorghum vulgare*.

Experiment 4

Effects of nutrient fertilizer on concentration of endogenous plant growth promoting substances of *S. vulgare* infected or non-infected by *S. hermonthica*

Procedure

Seeds of *S. vulgare* variety Dobbs were used in this experiment. About 150 pots of *S. vulgare* in sterilized non-infested clay soil were prepared. Clay soil infested with 30 mg *S. hermonthica* seeds per 12.5 cm diameter plastic pots were used to prepare an equal number of pots with infected *S. vulgare*. *S. hermonthica* seeds were of the Gezira Sudan strain. All plants received the soluble nutrient mixture normally used for the glass house plants but 75 pots from each group received in addition 2 mg/pot of nitrochalk (12% N) at 3 weeks and again at 6 weeks of age. When the plants were 8 weeks old, shoots were cut off just above the soil and the xylem exudate was collected as described by Elhiweris (1979). The collected exudate was bulked and freeze dried. Plant growth promoting substances in the exudate samples were extracted and purified using a solvent partition method (Hill 1975). Cytokinins collected in the final aqueous phase while gibberelins are in the final organic phase. The two hormones were purified and determined by thin layer chromatography and tobacco pith callus or barley endosperm bioassay.

a. Thin layer chromatography (TLC)

Ready-made 250 mm thick silica gel 20 × 20 cm thin layer chromatography plates (G/500/Ls-250), E. Merck, Darmstadt, West Germany, were used. Known volume of the final alcoholic solution corresponding to a known weight of the original freeze-dried material was streaked a few cm from the edge of the plate. Marker spots of known concentrations of the expected substances were spotted on both sides of the plates. Solvents used were ethyl acetate - chloroform - acetric acid (15:5:1 V/V) for the detection of gibberellins or n-butanol-28%, 0.88 ammonium hydroxide (4:1 V/V) for the detection of cytokinins. The solvent front was allowed to move exactly 15 cm from the starting line. The plates were dried and examined under U.V. light (ultra violet light) at wave length 253 n m for cytokinis or 356 n m for gibberellins and flourescent spots were noted and marked. The silica gel was then devided into 15×1 cm equal strips marked parallel to the starting line. The material from each strip was scrapped into seperate test tubes and eluted with ethanol. Cytokinins were eluted with the absolute ethanol in a water bath at 50°C for 1 hour (Ross 1970). The eluent was sieved through non-absorbant glass wool and was evaporated to dryness under vacuum. The residue was kept in dark at −15°C until required for the biological tests.

b. Tobacco pith callus bioassay

This method used by many research workers for the quantifiation of cytokinins measures the increase in both fresh and oven-dry weights of tobacco callus over a period of a few weeks of growth (Miller and Skoog 1953, Miller *et al.* 1955a, 1955b and 1956).

The dried residues of the eluents or standard amount of cytokinins were dissolved in 3 ml of distilled water and added to a 100 ml conical flask containing 27 ml of warm concentration of tobacco tissue culture medium. This was the modified preparation of Murashing and Skoog (1962) described by Witham *et al.* (1971). The flaks were then plugged with cotton pluggs covered with metal caps and autoclaved for 15 minutes at 121°C and 1.05 kg/cm^2 pressure. *Nicotiana tabacum* plants, variety "xanthi" were the source of the pith tissue. In a U.V. sterile room equal sized pieces of 5×5×4 mm from pith of the tobacco stem were prepared as described by witham *et al.* (1971). Three such pieces were transfered to each 100 ml Erlermayer conical flask containing autoclaved basal medium with the eluant from the chromatogram strips or the standard kinetin solutions (10^{-5}M to 10^{-10}M). All handling was carefuly conducted under sterilized conditions. The flasks were incubated in a growth room at 27±2°C and continuously illuminated at 40 ft. c. for four weeks. Three replicates from every solution on blank were prepared. The mean callus fresh weights per flask gave a response curve for the log. kinetin concentration of the known standards. Kinetin activity in the unknown solutions were then determined from this response curve.

c. Barley endosperm bioassay

This method been used commonly for the determination of gibberellins. The procedure used was that of Nicholls and Paleg (1963) as described by Witham *et al.* (1971). The amounts of reducing sugar in the vials were determined iodemetrically using alkaline copper reagent used by Hodge and Hafreiter (1962). These amounts were expressed as mg glucose equivalent per g initial dry weight. A typical dose response curve was drawn for different concentrations of G A_3 (10^{-6} g/ml – 10^{-10} g/ml) in the incubation medium and the amount of reducing sugars released in the medium. This dose response curve was then used to estimate the amount of G A_3 equivalent activity in the plant extracts been examined.

Results and Discussion

From the results of experiment 1, it is clear that there was a regular and generally consistant increase in shoot weights as nutrient was increased (Fig. 2). The shoot weights of non-infected *Sorghum* plants were 2-3 times greater than the infected. The relative response of the infected plants to nitrogen application was greater than in the non-infected control plants. The corresponding root systems of

Sorghum plants infected or non-infected with *Striga* showed a fairly similar pattern as shoot weights. The dry weights of roots generally increased as nutrient amount increased, but the root weights of the infected plants were more similar to those of the non-infected plants particularly with the greater amount of nutrient (Fig. 2). Addition of nutrient solution to infected plants, however, did not compensate for the decreased weights of shoots caused by infection. This is clear from the higher root/shoot ratio of the infected plants compared to the control (Table 1). Increase in nutrient concentration did not change the ratio in control plants very much but a decrease in the ratio of the infected plants with increased nutrient concentration was evident in the three harvests. This means that better shoot growth of infected plants was achieved with addition of nutrient solution.

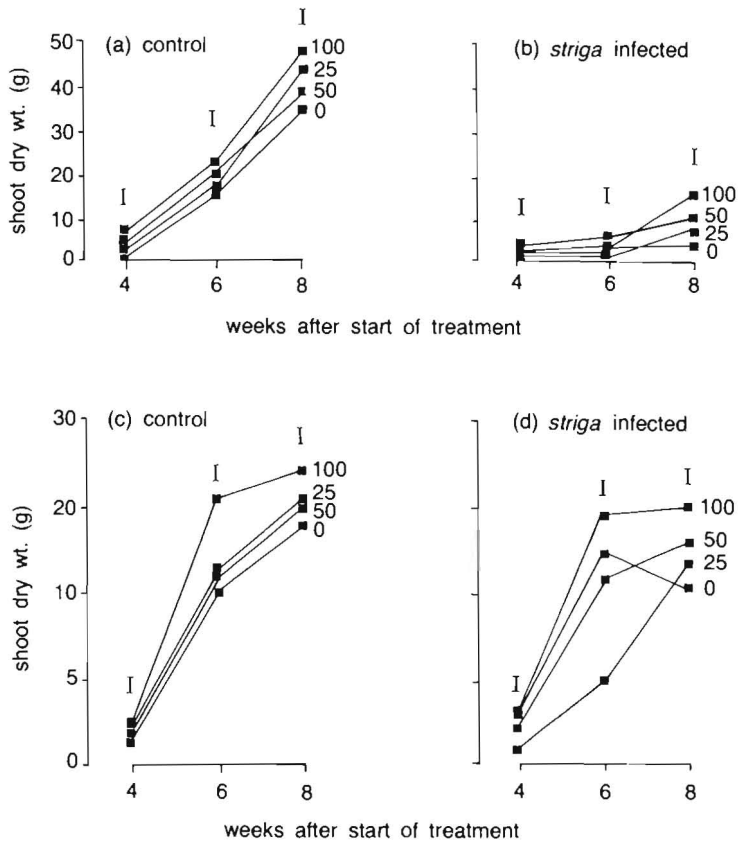

Fig. 2. Effects of Fison 211 nutrient solutions at 100, 50, 25 and 0 ml/pot/week on dry weights of shoots (a, b) and roots (c, d) of *S. vulgare* infected (b, d) and non-infected (a, c) with *S. hermonthica*. Vertical bars represent L.S.D. (p. 0.05).

Table 1. Root/shoot ratio of *Sorghum vulgare* infected or non-infected with *Striga hermonthica* and with different applications of Fison 211 nutrient solution.

***Striga* infection**	**Non-infected**			**infected**		
Weeks after start of treatment	**4**	**6**	**8**	**4**	**6**	**8**
ml. nutrient solution						
0	0.68	0.68	0.59	1.60	1.59	2.94
25	0.63	0.61	0.40	2.60	4.41	1.61
50	0.25	0.64	0.55	1.06	2.76	1.58
100	0.35	0.97	0.51	0.89	2.18	1.34

Addition of nutrient solution to the split-root system of non-infected plants (Exp. 2) resulted in an increase in shoot weights whether both halves of the root system were given half the amounts of nutrient solution or one half of the root system was all of a similar total nutrient solution. In contrast, half root system weights reflected their immediate nutrient supply with a very large and a very small root weight, when all the nutrients were given only to one half. Two intermediate sized roots with similar total weights were obtained when each half root system had half share of the nutrient supply (Fig. 3). This proved that a half root system lacking an immediate supply of nutrients can be strongly supported by a better supplied other half. The better supplied half is able to increase its growth to make up the deficiency of its deprived other half.

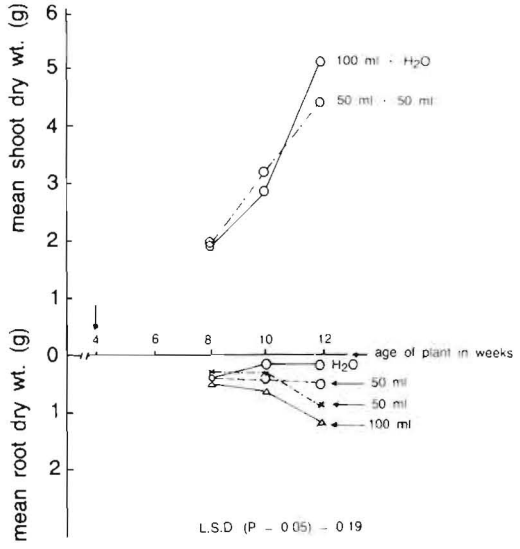

Fig. 3. Dry weights of shoots and half-root systems of *S. vulgare* plants given different nutrient treatments to split root systems. Arrow indicates time when Fison 211 nutrient used as

Application of nitrogen from ammonium sulphate to split-root systems of *Sorghum vulgare* infected or non-infected with *Striga hermonthica*, provided similar results as that obtained from experiment 2. From the results shown in table 2, it is clear however, that the increase in nitrogen resulted in an increase in plant weights. However, non-infected plants receiving 200 ug/ml of the fertilizer to one half of the root system and 0 ug/ml to the other half were significantly heavier than those receiving 100 ug/ml to both root halves. This effect was not clear in plants that had *Striga* infection on both halves or on one half of the root system. Although non-infected plants had shoot dry weights that averaged 27 at eight weeks, those with infected half root system showed an averaged shoot weight of only 17.5 g. Infection on both halves of the root system reduced the plant shoot dry weights to only 10 g. Differences in dry weights between root halves were statistically non-significant at the 4 and 6 weeks after the start of ammonium sulphate application. By 8 weeks, root halves receiving 200 ug/ml fertilizers were significantly larger than their unfertilized other half. When only half of a root system was infected with *S. hermonthica*, infected halves tended to be smaller than uninfected halves. But differences were only significant when infected halves had received 0 ug/ml ammonium sulphate and non-infected halves had received 200 ug/ml (Table 2).

In experiments 1 and 3 where *S. hermonthica* infested soils were used, the number of *Striga* seedlings parasatizing the host plants was determined (Fig. 4). Results from experiment 1 showed fewer *Striga* seedlings in pots receiving 100 ml nutrient solution (14 *Striga* seedlings emerged per pot) compared with 18-24 seedlings in other treatments. In control pots where only water was added (0 ug/ml nutrient solution) the number of *Striga* seedlings that emerged increased continuously over the 8 weeks and reached 60 seedlings/pot at the end of the experiment compared with 14-24 seedlings in the other treatments (Fig. 4-A). The application of nitrogen fertilizers at this early stage of the host growth *i.e.* one week after planting, resulted in a very vigorous growth. This however, supported fewer *S. hermonthica* parasites possibly by making host plant shoots use more of their own photosyenthate and depriving the parasite of adequate food during its early stage of establishment. This was confirmed by the results obtained from experiment 3 wherein there were considerable differences in the numbers of attached *Striga* seedlings below the ground and also of seedlings emerged above the ground (Fig. 4-B). When both root halves were infected there were more *Striga* shoots on half root systems given water than on other halves given 200 ug/ml ammonium sulphate. A fact which proves the severe effects of *Striga* parasitism under poor soils. When only one half root system was infected the number of *Striga* seedlings parasatizing on the host roots per pot was more than both half root systems were infected. This could be due to mere competition between *Striga* seedlings.

Table 2. Effcts of application of ammonium sulphate fertilizer on the dry weights (g) of shoots and root portions of *Sorghum vulgare* infected (+) or non-infected (−) with *Striga hermonthica*.

***Striga* infection on root halves**	**Ammonium Sulphate (ppm) and *Striga* infection**	**Weeks after start of treatment**		
		4	**6**	**8**
-A-	200^-	0.61	1.66	4.08
Both root halves	0^-	0.46	1.18	2.36
non-infected	Shoot	4.57	14.36	29.69
	100^-	0.65	1.69	2.10
	100^-	0.71	1.95	2.88
	Shoot	5.58	12.01	24.87
-B-	200^+	0.57	2.43	3.78
Both root halves	0^+	0.55	0.91	3.31
infected	Shoot	4.40	5.59	11.69
	100^+	0.82	1.97	3.01
	100^+	0.57	1.41	3.19
	Shoot	4.69	6.69	8.23
-C-	200^+	0.59	3.26	3.86
One root half infected	0^+	0.70	2.29	4.35
	Shoot	4.47	10.14	16.06
	200^-	0.50	3.99	4.56
	0^+	0.62	1.18	2.73
	Shoot	5.59	8.78	19.06
	100^-	0.41	3.46	5.97
	100^+	0.81	2.13	2.70
	Shoot	5.13	8.80	17.40

L.S.D. (p 0.05) between root portions 6 weeks = 0.527
L.S.D. (p 0.05) between root portions 8 weeks = 1.540
L.S.D. (p 0.05) between shoot portions 6 weeks = 1.390
L.S.D. (p 0.05) between shoot portions 8 weeks = 3.460

The significant increase in *Sorghum* shoot growth with nitrogen fertilizer application was partially explained from the results obtained from experiment 4. In this experiment the concentration of the growth promoting substances calculated as "G A_3 or kinetin equivalent" was increased with the addition of nitrogen fertilizer to both infected or non-infected *S. vulgare* (Fig. 5). There was no kinetin apparent activity in the low levels of nitrogen treatments. At high levels of nitrogen fertilizers, activity increased at zone I & III and new activity peaks were evident at zones IV and V. With Striga infection however, addition of low nitrogen levels to plants resulted in much lower activities especially at zone III, IV, V. The calculated amounts of cytokinis as "kinetin equivalents" are given in Table 3. From this table it is clear that infection lowered the concentration of cytokinin per ml of exudate to

14% of that in non-infected plants. With added nitrogen, infection exerted less effect on the concentration of cytokinis but reduced it to 8% of the non-infected control. Addition of nitrogen fertilizer however, doubled the amount of cytokinin in infected plants and triplied it in non-infected plants. This resulted in a better growth of the host plant even in the presence of the parasite.

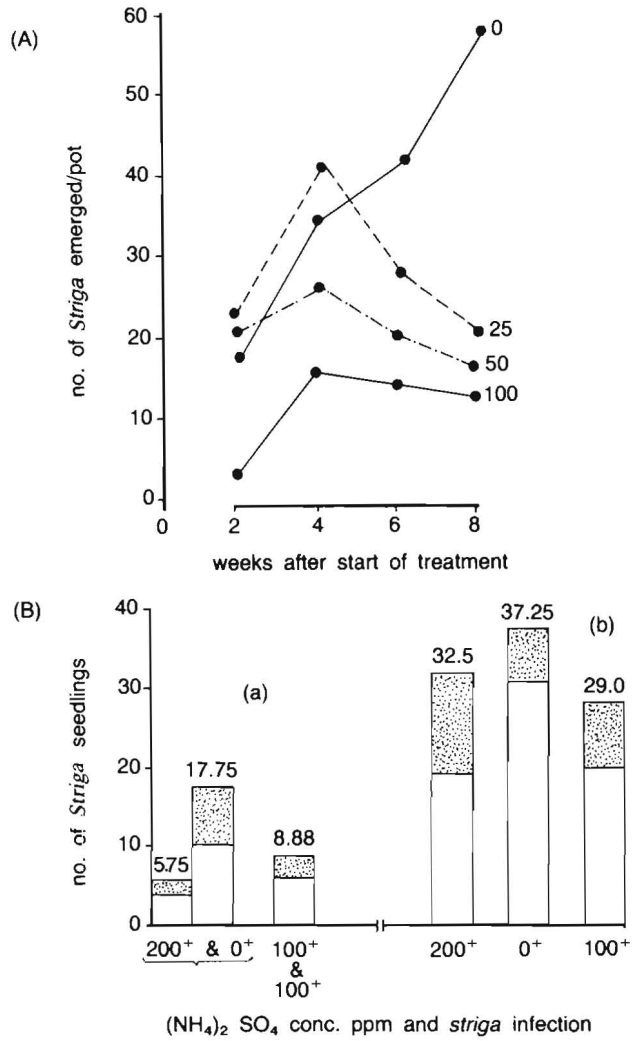

Fig. 4. Numbers of *S. hermonthica* (A) on non-split root system of *S. vulgare* treated with Fison 211 soluble nutrient solution; (B) on roots of *S. vulgare* (a) when both half-roots were infected and (b) when one half root system is infected and treated with ammonium sulphate shoots below ground (open columns) and shoots above ground (hatched columns) and total number per half root given above columns.

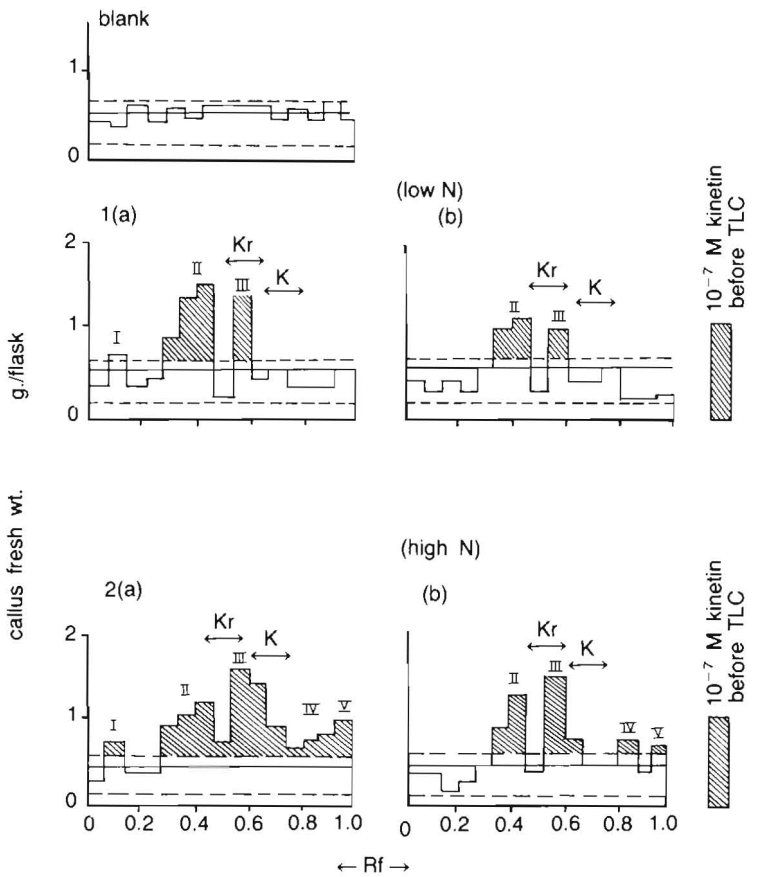

Fig. 5. Cytokinin activity assayed by tobacco callus growth of TLC Samples of xylem exudate of *S. vulgare*, non-infected (a) and infected (b) by *S. hermonthica*. Positions of Kinetin (K) and Kinetin reiboside (Kr), indicated by horizontal bars. Solid horizontal line represents the mean callus response to blank segments. Shaded areas indicate significant response at 5% confidence limits.

Figure 6 shows the gibberelin activities in plant samples determined by the barley endospem test. There was at least five zones of activities in plants grown under lower nitrogen levels and in the absence of *Striga* infection. Addition of nitrogen fertilizer increased the activity of zone V. The total amount of gibberellins calculated as "G A equivalent", increased with the increase of nitrogen fertilizer in both infected and non-infected plants. The increase in gibberellin activities was substantial and 53 and 67 times more in control plants per exudate concentration and per plant respectively (Table 3). In the infected plants, however, the comparable figures were 15 and 24 times more.

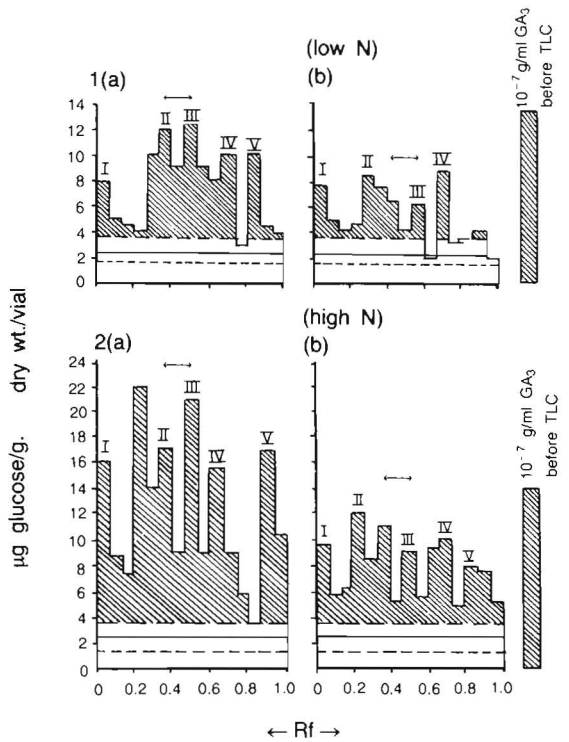

Fig. 6. Gibberellin activity assayed by barley endosperm response of TLC samples of xylem exudate of *S. vulgare* (a) non-infected (b) infected by *S. hermonthica*. The position of GA3 is indicated by horizontal bars. Other information is as given in Fig. 5.

Table 3. Concentrations of plant growth promoting substances (ng GA3 equivalent and ng kinetin equivalent) in the xylem exudates of *Sorghum vulgare* infected (+) or non-infected (−) with *Striga hermonthica* and receiving nitrogen fertilizer (duplicate samples and triplicate determinational sample).

Nitrogen level and *Striga* infection	Kinetin equivalent		Gibberellic acid equivalent	
	ng/ml exudate	ng/plant	ng/ml exudate	ng/plant
-1-				
a) Low nitrogen				
+	4.155	5.001	0.491	0.651
−	29.779	65.887	4.173	9.181
b) High nitrogen				
+	5.950	11.407	7.383	15.604
−	65.397	205.823	223.698	698.066

The promoting effects of these two growth substances are well known from the work of many research workes. The stimulation of cell elongation and the transformation of dwarf plants into normal ones and the elongation of leaf growth are some of the effects of gibberellins on plant growth (*e.g.* Wright 1966, Harade and Vergara 1972 and Soni and Kaufman 1972). Cytokinins on the other hand are well known for their promotion of plant growth by cell devision (Skoog and Armstrong 1970). The increase in both gibberellins and cytokinins resulting from added nitrogen fertilizer suggests that the vigorous growth of the nitrogen treated plants was due in part to these growth factors. These results confirm that use of nitrogen fertilizers is effective for control of *S. hermonthica* parasitism on *S. vulgare* plants.

Conclusions

1. Application of nitrogen fertilizer to both *Striga hermonthica* infected and non-infected *Sorghum vulgare* plants resulted in an increase growth of plants.
2. The increase in shoot weights and root weights from addition of nitrogen to infected *S. vulgare* plants was relatively more than that of non-infected plants.
3. Early application of nutrient solution lowered the number of parasatizing *Striga* plants and increased the growth of the host plant substantially.
4. Fewer *S. hermonthica* plants were established with the largest nutrient treatment given to infected half-root system when the other half-root system was also infected.
5. Substances with similar activities to cytokinins and gibberellins are present in the xylem exudates of *S. vulgare*.
6. Infection with *S. hermonthica* severely decreased the amount of cytokinin and gibberellin like substances in the xylem exudates of *S. vulgare* plants.
7. Addition of nitrogen increased the amount of cytokinins and gibberellins in the xylem exudate of *S. vulgare* plants infected or non-infected by *S. hermonthica*.
8. The reduction of emerged *S. hermonthica* seedlings associated with the increase in growth of roots and shoots of *S. vulgare* plants that received nitrogen fertilizer proved the recommendation for the use of nitrogen fertilizers in the control of *S. hermonthica* parasitism on *S. vulgare* plants.

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استعمال الأسمدة الآزوتية وعلاقتها بالتطفل

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في هذه الدراسة تم بحث تأثير السماد (كبريتات النشادر) $(NH_4)_2 SO_4$ أو محلول مغذي فايسون ٢١١ ، (Fison 211) على نمو نبات الذرة الرفيعة *(Sorghm vulgare)* المصاب وغير المصاب بطفيل البوده *(Striga hermonthica)* .

فلقد أثبتت هذه الدراسة التأثير الإيجابي لاستعمال الأسمدة بالزيادة الملحوظة في وزن الجذور والسيقان لنبات الذرة. وفي تجارب أخرى أضيف فيها السماد لنصف المجموع الجذري بتركيزات مختلفة وجد أن الجزء من المجموع الجذري المعامل بمحلول مركز تركيزه: ٢٠٠ جزء في المليون كبريتات النشادر، ينمو بدرجة أكبر من الجزء الثاني من الجذور في نفس النبات والذي عومل بالماء فقط. في الوقت نفسه نمت أجزاء المجموع الجذري المعاملة بتركيزات متساوية تساوي نصف التركيز الكامل أي (١٠٠ جزء في المليون) إلى درجة متساوية. وفي كلتا الحالتين سواء أضيف التركيز الكامل للسماد لنصف المجموع الجذري أو قُسم على نصف المجموع الجذري بالتساوي، فإن نمو المجموع الخضري واضح ولا يختلف كثيراً مع اختلاف المعاملات. فإن الزيادة في نمو الجذور المعاملة بالسماد عوضت من عجز النصف الثاني غير المعامل به.

وعلى عكس من تأثير السماد على نمو العائل فقد أثبتت هذه الدراسة نقص ملحوظ في عدد نباتات الطفيل الظاهرة فوق سطح التربة مما يثبت أنه في حالة التطفل فإن زيادة التركيزات للسماد تزيد من نمو العائل مما يضيّق الفرصة أمام نمو الطفيل وإلحاقه الضرر بالعائل. هذا التأثير يكون أكثر وضوحاً عندما تكون المعاملات في وقت مبكر بعد زراعة المحصول.

ولإيجاد التفسيرات الصحيحة لهذه العلاقة تم تحليل العصارة الخشبية للنبات العائل وتحديد التركيزات للهرمونات المنشطة للنمو مثل السايتوكاينينات والجبرليتات وتأثير السماد عليها. ولقد اتضح من هذه الدراسة ما للسماد من تأثير على تركيز تلك الهرمونات. فهناك زيادة ملحوظة في تركيز هذين الهرمونين في نبات الذرة الرفيعة مصاب وغير مصاب بالطفيل. ولقد أثبتت دراسات الكثير من الباحثين ما لهرمونات النمو تلك من تأثير على زيادة طول وحجم النباتات المختلفة وبذلك يمكن الربط بين ما توصلنا إليه في هذه الدراسة من زيادة في نمو النبات وزيادة في تركيز هرمون السايتوكاينينات والجبرلينات. فالزيادة في هرمون النمو هي التي أدت إلى الزيادة في نمو النبات لحد كبير وبذلك تغلب نبات الذرة على الطفيل بسرعة النمو والاستفادة مما كوّن من غذاء فأصبح تأثير الطفيل قليل أو منعدم. وقد تكون إضافة الأسمدة الآزوتية قد ساعدت النبات على تكوين الغذاء الكافي مما جعل منافسه لا أثر له على نموه إطلاقاً.

وبذلك يمكن إثبات أهمية استعمال الأسمدة الآزوتية في حقول الذرة الرفيعة المصابة لمكافحة أضرار تطفل نبات البوده عليه.