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EFFECT OF N + P AND MANGANESE FERTILIZATION LEVELS ON GROWTH AND SEED YIELD OF SOYBEAN (*Glycine Max*, L. Merill).

Allam, S. A.
Dept. of Agron., Fac. of Agric., Moshtohor – Zagazig Univ.

ABSTRACT

Two field experiments were conducted at the Experiment and Research Center, Faculty of Agriculture at Moshtohor, Zagazig University during 1996 and 1997 seasons. Experiments were designed to study the response of growth and seed yield of soybean to levels of N + P fertilizer (N 0 + P 0, 30 kg N + 15 kg P_2O_5/fed and 60 kg N + 30 kg P_2O_5/fed) and manganese levels (0, 2.5 , 5.0, 7.5 and 10.0 kg/fed) as soil application in combination of 15 treatments. Increasing NP fertilization rates up to 60 kg N + 30 kg P_2O_5/fed significantly increased plant height, number of branches, number of pods and seeds per plant, seed yield per plant, 100-seed weight, seed yield (kg/fed) and protein percentage of soybean.However,this treatment decreased oil percentage of seeds. Plant height, number of branches/plant number of pods and seeds per plant, seed yield per plant, 100-seed weight, seed yield (kg/fed). As will as protein and oil percentages increased significantly by increasing manganese level up to 5.0 kg/fed.

Higher seed yield per plant, 100-seed weight as well as seed yield (kg/fed), protein and oil percentages significantly increased by application of N + P fertilizer at 60 kg N + 30 kg P_2O_5/fed with 5.0 kg/fed of manganese as soil application in the two growing seasons, respectively.It could be concluded that under the circumstance of these experiments, would recommended to fertilize soybean with 60 kg N + 30 kg P_2O_5/fed with soil application of 5.0 kg/fed Mn (Mn-EDTA-15 % Mn).

INTRODUCTION

Soybean (*Glycine max*, L. Merill) is a promising crop due to its value for both human and animal feeding. It is a unique legume crop which provides rich amonts of both oil and protein. It contributes well in solving the protein – energy malnutrion problems that exist in the rural parts on the international and national evils. Seed yield depends on the available varieties, environmental conditions and management practices. Among such practices is the appropriate fertilization with macro and micronutrients. Increasing nitrogen rates increased plant height, pods number/plant, 100-seed weight and seed yield/fed (Abd-Alla, 1983 ; Attia, 1983 ; Sultan *et al.*, 1988 and Rady *et al.* 1988). Protein and seed percentages were increased whereas oil percentage decreased by increasing nitrogen rates (Attia, 1983 ; Rady *et al.*, 1988 and Sharief, 1993). Pal *et al.* (1989) reported that increasing P_2O_5 rates up to 26.4 kg/ha increased seed yield by 21 % over the control. Maximum plant height, branches and pods number/plant as well as seed yield/fed were obtained by applying 60 kg N + 30 kg P_2O_5/fed (Kandil, 1985 and Sharief, 1993). Also, seed yield/acre was increased by 10 2 % as a results of $MnSo_4$ application at a rate of 3.6 kg/acre (Soliman and Farah, 1985). Whereas, in other studies Mascagni and Cox (1985) found that seed yield/ha was increased by foliar application of $MnSo_4$ application at a rate of 0.6 kg/ha.

Concerning to the combined application of macro and micronutrients, Soliman and Farah (1985) indicated that the application of 40 kg N + 30 kg P_2O_5/acre with foliar application of $MnSo_4$ application at a rate of 3.6 kg/acre recorded maximum increases in seed yield of soybean.

MATERIALS AND METHODS

Two field experiments were carried out at the Research and Experimental Center of the Faculty of Agriculture at Moshtohor, Zagazig University, during the two successive growing seasons of 1996 and 1997. The soil of the field experiment was clay in texture with pH value of 7.9 and 1.9 % organic matter content, 30 ppm available P, 17.8 ppm available N and 6 ppm available Mn. The proceeding crop in both seasons was Egyptian clover (*Trifolium alexandrinum*, L.). Each experiment included fifteen treatments which were the combination between three treatments of N + P and five levels of Mn.

Experimental design was split-plot with four replicates. The three treatments of N + P were randomly arranged in the main plots which were:

1- N0 P0: Without any application of N or P (control).
2- N30 P15: 30 kg N + 15 kg P_2O_5/fed were applied.
3- N60 P30: 60 kg N + 30 kg P_2O_5/fed were applied.

The five levels of manganese were randomly allocated in the sub plots. These levels were 0, 2.5, 5.0, 7.5 and 10.0 kg Mn/fed applied to the soil. Experimental unit area was 10.5 m^2 (1/400 fed).

Soybean seeds cv. Clark were sown on May 10th and May 5th in the first and second growing seasons, respectively. All of the other recommended cultural practices as in the region were followed properly in both seasons. Plants were thinned to two plants/hill at 10 cm a part after three weeks from sowing.

Nitrogen fertilizer was applied in the two equal doses before the first and second irrigation in the form of Urea (46 % N). Phosphorus was applied at planting as calcium superphosphate (15.5 % P_2O_5/fed). Manganese (as Mn-EDTA-15 % Mn) was broadcasted and thoroughly mixed into the soil (with cultivation) before the first irrigation.

At harvesting, samples of 10 plants were randomly chosen from each plot to estimate the following studied parameters: plant height (cm), number of branches/plant, number of pods/plant, number of seeds/plant, seed yield/plant (g), 100 –seed weight, protein and oil percentages. Meanwhile, seed yield (kg/fed) was determined from inner three ridges of each sub plots. Seeds protein percentage determination was carried out by the improved microkjeldahl method. Oil content in the seeds was also estimated according to the A.O.A.C., 1980 method.

The recorded data were statistically analysed and differences between means were compared using the Least Significant Differences (LSD) as indicated by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

I- Effect of N + P fertilizer treatments:

A- Growth, yield and its components:

Results in Table (1) show that plant height and number of branches/plant were significantly affected by N + P the applied fertilization treatments. Increasing N + P rates up to 60 kg N + 30 kg P_2O_5/fed

significantly recorded increases of plant height and number of branches/plant compared with the control and applied of 30 kg N + 15 kg P_2O_5/fed. This trend was expected since nitrogen prolonged the vegetative period resulting in increased of the metabolic process within the plants through their direct effect on the photosynthesis and on the enzymatic reaction. Similar conclusion were reported by Kandil (1985) and Saker *et al.* (1988).

It is clear from the data in Table 1 that number of pods/plant, number of seeds/plant, seed yield per plant and 100-seed weight increased when soybean plants were fertilized with N + P. Results in this Table showed that all yield components of soybean were significantly affected by application of N + P rates compared with the control in both seasons. Increasing N + P fertilization up to 60 kg N + 30 kg P_2O_5/fed significantly gave the highest values of the number of pods/plant, number of seeds/plant, seed yield per plant and 100-seed weight as compared with the control and the other treatment (30 kg N + 15 kg P_2O_5/fed). These results were obtained in the two growing seasons. Meanwhile, similar results were obtained by Sharief (1993) and Osman *et al.* (2000).

These results could be due to the well known facts that nitrogen has a major effect on most of the major plant constituents as amino-acids, proteins, chlorophyll, enzymes, vitamins and organic acids. Such constituents enhance the growth and productivity of crop plans. Also, phosphorus has a major role in photosynthesis activities, energy transfer and carbohydrates metabolism of plants. Moreover, it is a part of the cells, nucleus, and it is present in the cytoplasm, and its role in cell division in very essential.

The importance of N and P in plant functions was reflected on the studied growth parameters and the yield and its components of soybean.

Data also indicate that seed yield in kg/fed was significantly affected by N + P application in the two growing seasons as shown in Table 1. The highest soybean seed yield (kg/fed) was produced by increasing N + P rate up to 60 kg N + 30 kg P_2O_5/fed, while the lowest seed yield was obtained from the control treatment in the two seasons. The increases in seed yield/fed of soybean due to the increases in pods and seeds number per plant as well as 100-seed weight as a result of increasing N + P fertilizer levels were similarly described by Abd-Alla (1983) ; Kandil (1985) ; Rady *et al.* (1988) and Sharief (1993).

B- Chemical composition:

In each of the two growing seasons, protein and oil percentages of soybean were significantly affected by N + P fertilization treatments as presented in Table 1. Increasing N + P rates up to 60 kg N + 30 kg P_2O_5/fed

significantly increased protein percentage however, oil percentage was decreased compared to the control treatment (no N + P fertilizer) and other fertilization treatment of 30 kg N + 15 kg P_2O_5/fed in the two growing seasons. Similar results were recorded by Attia (1983) Rady *et al.* (1988) and Sharief (1993)

Table 1: Effect of N + P fertilization treatments on the growth, yield components, yield and seed quality of soybean in 1996 and 1997 seasons.

Cactharacters / N+P fertilizer (kg/fed)	Plant heiht (cm)	Number of branches /plant	Number of pods /plant	Number of seeds /plant	Seed yield (g/plant)	100-seed weight (g)	Seed yield (kg/fed)	Protein %	Oil %
First season (1996)									
N 0+P 0 (control)	65.0	2.12	26.40	61.30	16.03	17.58	1019.00	34.01	21.95
N 30 + P 15	72.9	2.41	35.60	82.10	17.21	18.48	1169.00	37.09	21.67
N 60 + P 30	81.3	2.49	42.45	106.08	18.85	18.86	1301.00	40.80	21.65
LSD at 5 %	3.8	0.16	2.51	6.02	0.05	0.13	21.84	0.10	0.15
Second season (1997)									
N 0+P 0 (control)	77.8	1.33	27.60	70.60	20.00	15.30	894.00	36.14	20.00
N 30 + P 15	87.3	1.77	36.45	98.82	21.20	16.50	1234.00	40.13	18.70
N 60 + P 30	92.5	2.25	45.85	126.49	22.87	17.83	1439.00	41.78	18.43
LSD at 5 %	3.6	0.21	2.64	7.37	0.15	0.11	31.59	0.96	0.12

II- Effect of manganese application:

A- Growth, yield and its components:

Data in Table 2 indicated that the effect of manganese on plant height and number of branches/plant were significantly affected in the two seasons. Tallest plants and highest number of branches of soybean plants were recorded by soil application of Mn at a rate of 5.0 kg/fed compared to the other manganese fertilization levels of 2.5, 7.5 and 10.0 kg/fed as well as the control (no Mn added) during the two seasons. Such effect of Mn may be due to the stimulation of the metabolic process on the plants through their direct effect on the enzymatic reactions and activities as recorded by Abd EL-Gawad *et al.* (1988) and Sharief (1993) who reported that microelements as a spray tended to increase the concentration of chlorophyll a + b and carotenoids as well. These result will increasing photosynthesis and encourage plant growth and number of branches per plant in growth and development processes.

Results in Table 2 reveal that, soil application of Mn at a rate of 5.0 kg/fed significantly increased number of pods, number of seeds and seed yield per plant as well as 100-seed weight in the two growing seasons compared with the check treatment (no Mn added). Over the two seasons, the applied Mn at a rate of 5.0 kg/fed recorded the highest values of these parameters compared with the other treatments. Such results might be due to the effect of Mn on some physiological processes in soybean plants. Such obtained data indicate that seed yield per feddan of soybean significantly increased at any of the applied manganese fertilization compared to the control in the two seasons (Table 2). Application of Mn at a rate of 5.0 kg/fed recorded the highest soybean yield (kg/fed) in the two growing seasons. Such results could be due to the obtained increases in pods and seed number per plant which may have resulted from either the additional flower production and/or the reduced abortion of flowers or pods (Banks, 1982) Similar results were obtained by Abd EL-Gawad *et al.* (1983), Sakr *et al.* (1988), Sharief (1993) and Sultan *et al.* (2003).

B- Chemical composition:

The results in Table 2 reveal that, soil application with Mn significantly increased each protein and oil percentages in soybean seeds in the two growing seasons. Highest protein and oil percentages were recorded when soybean plants were fertilized with Mn at a rate of 5.0 kg/fed in the two studied seasons. Whereas, the lowest values were recorded for the highest rate of manganese (10 kg Mn/fed). Similar results were found by Abd EL-Gawad *et al.* (1988) and Saker *et al.* (1988).

The positive effect of Mn in increasing protein and oil percentages in seeds may be mainly attributed to the fact that Mn plays an important role in

Table 2: Effect of manganese levels on the growth, yield components, yield and seed quality of soybean in 1996 and 1997 seasons.

Characters / Treatments Mn (kg/fed)	Plant height (cm)	Number of branches /plant	Number of pods /plant	Number of seeds /plant	Seed yield (g/plant)	100-seed weight (g)	Seed yield (kg/fed)	Protein %	Oil %
First season (1996)									
0	68.6	2.19	33.42	79.82	17.03	18.18	1140.83	36.92	21.52
2.5	76.8	2.41	36.42	86.81	17.38	18.58	1209.17	37.53	21.73
5.0	80.5	2.63	38.33	91.38	17.80	18.78	1250.83	37.75	21.88
7.5	70.8	2.38	34.50	81.96	17.42	18.10	1141.67	37.22	21.50
10.0	68.4	2.07	31.85	75.77	17.18	17.87	1073.33	36.88	21.35
LSD at 5 %	4.9	0.20	3.25	7.77	0.07	0.17	28.19	0.12	0.19
Second season (1997)									
0	81.3	1.59	35.75	94.11	20.98	16.45	1105.00	39.35	18.90
2.5	88.3	1.81	38.17	101.72	21.50	16.65	1195.00	39.90	19.20
5.0	92.9	2.22	39.33	108.35	21.83	16.78	1283.33	40.12	19.21
7.5	85.8	1.70	36.25	98.33	21.37	16.46	1204.17	39.61	18.97
10.0	80.8	1.58	33.67	90.67	21.10	16.36	1159.17	37.72	18.87
LSD at 5 %	4.7	0.27	3.40	9.52	0.19	0.14	40.79	1.23	0.15

protein synthesis through some of the enzymatic activities. So, Mn more likely acts as an enzyme stimulus for a variety of metabolic and enables functions in plants, while all lead to more growth and productivity of crop plants

III- The interaction effect:

Data for the interaction of the applied fertilization of N + P levels and Mn rates on the studied soybean parameters are presented in Table 3. Such interaction significantly affected 100-seed weight, seed yield/plant, seed yield (kg/fed), protein and oils percentages.

Application of N + P fertilization at a rate of 60 kg N + 30 kg P_2O_5/fed combined with Mn at a rate of 5.0 kg/fed recorded the maximum highest values of the studied characters of soybean in the two growing seasons. Similar results for the effect of N + P with Mn (as foliar application) were recorded by Soliman and Farah (1985) and Sharief (1993).

It can be concluded that to obtain higher 100-seed weight, seed yield/plant, protein and oil percentages and seed yield/fed under the circumstance of these experiments, would recommended to fertilize soybean with 60 kg N + 30 kg P_2O_5/fed with soil application of 5.0 kg/fed Mn (Mn-EDTA-15 % Mn).

Table 3: The interaction effect of N + P fertilization levels and manganese rates on some of the significantly affected parameters of soybean during the two seasons.

Fertilization treatments (kg/fed)		100-seed weight (g)		Seed yield (g/plant)	Seed yield (kg/fed)	Protein %		Oil %
N + P	Mn	1996	1997	1996	1997	1996	1997	1997
N 0 + P 0	0	17.65	15.30	15.85	875.0	33.95	36.00	20.10
	2.5	17.80	15.35	16.05	917.5	34.10	36.40	20.25
	5.0	17.63	15.40	16.45	930.0	34.20	36.45	19.93
	7.5	17.45	15.18	15.95	897.5	33.95	36.00	19.80
	10.0	17.35	15.25	15.85	850.0	33.85	35.85	19.90
N 30 + P 15	0	18.25	16.43	16.80	1150.0	36.75	39.55	18.45
	2.5	18.68	16.65	17.25	1242.0	37.35	40.35	18.85
	5.0	18.83	16.70	17.55	1330.0	37.55	40.55	19.00
	7.5	18.40	16.40	17.35	1252.5	36.95	40.30	18.75
	10.0	18.23	16.30	17.10	1197.5	36.85	39.90	18.45
N 60 + P 30	0	18.65	17.63	18.45	1290.0	40.05	42.50	18.15
	2.5	19.29	17.95	18.85	1425.0	41.15	42.95	18.50
	5.0	19.88	18.25	19.40	1590.0	41.50	43.35	19.70
	7.5	18.45	17.18	18.95	1462.5	40.75	42.70	18.55
	10.0	18.03	17.53	18.60	1430.0	40.55	37.40	18.25
L.S.D. at 5 %		0.29	0.24	0.13	70.6	0.22	2.14	0.27

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تأثير معدلات السماد النيتروجينى والفوسفور والمنجنيز على نمو ومحصول فـول الصويا

صلاح عباس حسن علام
قسم المحاصيل – كلية الزراعة بمشتهر – جامعة الزقازيق (فرع بنها).

أقيمت تجربتان حقليتان بمركز البحوث والتجارب الزراعية بكلية الزراعة بمشتهر خـلال موسمى ١٩٩٦ و١٩٩٧ بهدف دراسة إستجابة فول الصويا للتسميد بعناصر النيتروجين والفوسفور والمنجنيز المخلبى بمعدلات مختلفة. وأجريت التجربة فـى أرض طينيـة رقـم حموضـتها ٧,٩ ومحتواها من المادة العضوية ١,٩ % والفوسفور الميسر ٣٠ جزء فى المليون والنيتروجين ١٧,٨ جزء فى المليون والمنجنيز ٦ جزء فى المليون. وإشتملت التجربة على ١٥ معاملة هى عبارة عن التوافق بين ثلاثة معدلات للتسميد بعنصرى النيتروجين والفوسفور كالتالى:
١- بدون إضافة (كنترول). ٢- ٣٠ كجم نيتروجين + ١٥ كجم فو٢أ٥/فدان.
٣- ٦٠ كجم نيتروجين + ٣٠ كجم فو٢أ٥/فدان. مع خمسة مستويات إضافة للمنجنيز فى صورة منجنيز مخلبى إضافة أرضية (صفر ، ٢,٥ ، ٥,٠ ، ٧,٥ و ١٠,٠ كجم منجنيز/فدان).
وأظهرت النتائج الآتى:
١- أدى التسميد بمعدل ٦٠ كجم نيتروجين + ٣٠ كجم فو٢أ٥/فدان إلى زيادة معنوية فى كل من: إرتفاع النبات ، عدد الفروع للنبات ، عدد القرون للنبات ، محصول البذور للنبات ووزن المائة بذرة. وأيضا تفوق محصول البذور (كجم/فدان) ونسبة البروتين. بينما إنخفضت نسبة الزيت فى كلا موسمى الدراسة.
٢- أدت إضافة المنجنيز بمعدل ٥,٠ كجم للفدان إلى زيادة معنوية فى إرتفـاع النبـات ، عـدد الفروع للنبات ، عدد القرون للنبات ، عدد البذور للنبات ، محصول البذور للنبات ووزن المائة بذرة ومحصول البذور للفدان وأيضا نسبة البروتين والزيت فى كلا الموسمين.
٣- تحقق أعلى محصول من بذور فول الصويا بالكجم/فدان من التسـميد بمعـدلات ٦٠ كجـم نيتروجين + ٣٠ كجم فو٢أ٥/فدان مع معدل ٥,٠ كجم للفدان وكانت الزيادة معنوية.
٤- تحت ظروف هذه الدراسة يوصى بتسميد فول الصويا بمعدل ٦٠ كجم نيتروجين + ٣٠ كجم فو٢أ٥/فدان إضافة أرضية مع ٥ كجم منجنيز/فدان للحصول على أعلى نسبة مـن البـروتين والزيت.