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Residual Effect of Groundnut and Soil Amendments on the Performance of Gram under Rainfed Conditions

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Abstract: In order to provide conducive environment for groundnut growth and pig penetration, two soil amendments methods using various levels of gypsum (0, 250, 500 and 750 kg ha^{-1}) and silt (25, 50 and 75%) were applied. Results showed that days to flowering and maturity, nodules $plant^{-1}$, pod $plant^{-1}$ grain yield (kg ha^{-1}) and biomass were significantly ($p < 0.01$) affected by SA and GNR, while the effect on emergence m^{-2} and 1000-grains weight was non significant. GNR and SA had significantly delayed flowering and maturity and significantly more nodule $plant^{-1}$, pod $plant^{-1}$, biomass yield and grain yield as compared with control.

Key words: Residual effect, soil amendments, gram, gypsum, silt, grain yield

Introduction

Judicious use of commercial fertilizer not only reduce the cost of production and also minimize the threat to environmental pollution. Excluding commercial fertilizer application from the farming system in not feasible as the soil reserve of the major nutrients has already exhausted and most of the arid land has less than 1% organic matter (Lemee, 1955). Organic matter contents of bench mark soils of Pakistan ranges from 0.03 to 2.16% with mean value of 0.40% (Khan, 1986). Ninety five percent of soils of NWFP in irrigated tract of different districts had less than 1% organic matter (Bhatti *et al*., 1997). To restore the soil nutrients reserve for sustainable agriculture organic matter (O.M) in the form of crop residue, farmyard manure etc. has to be recycled. The rate of nitrogen mineralization is dependent on cropping practice, tillage intensity (El-Haris *et al*., 1983), fertilizer application (Janzen, 1987), crop residue (Smith and Sharpley, 1990), soil texture (Ladd *et al*., 1992), pore spaces (Amato and Ladd, 1992) and climatic factors (Amato *et al*., 1987).

Azam (1988) reported that under arid climatic condition the humic substances undergo at relatively rapid turnover as a result soil are poor in organic matter content. As for as the soil type is concerned clay contents of soil may have positive effect on the synthesis and stability of humic compounds. The use of symbiotically fixed nitrogen produced by properly managed legume in crop rotation may be a means of reducing current agricultural energy cost (Groya and Sheaffer, 1983). Bairrao *et al*. (1983) reported that increase in grain yield from 3.0 to 3.3 t ha^{-1} due to inclusion of legumes in rotation. Marcellos (1984) reported that the benefit to wheat from preceding legumes was at least equivalent to 50 kg nitrogen ha^{-1}. Leguminous crop can build up and contribute a significant amount of nitrogen to the subsequent crop (Power and Doran, 1988).

Keeping in view the importance of crop residue and soil amendments an experiment was designed, where gram was sown after the harvest of groundnut with aim to reduce the cost of production on ploughing/seedbed preparation for gram.

Materials and Methods

The study was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during the period of 1998-2000. A sub plot of 3 x 8.7 m^2 replicated four times in randomized complete block design. Seed was sown at the rate of 50 kg ha^{-1}, having row to row distance 30 cm. Soil amendments were:

(a) Gypsum @ 0, 250, 500 and 750 kg ha^{-1} and (b) Silt @ 25, 50 and 75 % and No residue.

The following procedure was used for soil amendments:

The top (3.5 cm) fertile soil was removed in all four sides of each subplot. Each subplot was dug upto a depth of 34.5 cm. In case of 75% soil amendment with silt the removed earth equal to 3.75 hand carts was taken out of the field and replaced by the same volume of silt, uniformly spread and thoroughly mixed with bottom and top soil. In case of 50% soil amendment with silt about 2.5 hand carts of clay soil was removed after the removal of top 23 cm clay soil around the plot and replaced by the same amount of silt and uniformly mixed. In case of 25% soil amendment with silt the above procedure was adapted with the volume of almost 1.25 hand carts of the clay removal and replacement of 11.5 cm top clay soil by silt soil and then was thoroughly mixed and levelled. NP was applied at the rate of 20:60 kg ha^{-1} as basal dose. "No residual treatment" was included in the present study for comparison with residual and soil amendments. Physio-chemical analysis of soil were determined by method as given by Black (1965) (Table 1). Statistical analysis were performed by the methods given by Gomez and Gomez (1976). LSD test was applied at 5% probability levels.

Table 1: Physio-chemical analysis of soil before sowing and after harvest of gram crops

Treatments	Lime*	Lime**	O.M	O.M
NGR	15.4	14.3	62.0	64.0
Control	15.2	13.4	65.0	68.0
250 Kg ha^{-1} Gypsum	14.9	12.9	66.0	69.0
500 kg ha^{-1} Gypsum	14.3	11.9	82.0	87.0
750 kg ha^{-1} gypsum	13.4	11.1	73.0	81.0
25% Silt	15.2	14.0	89.0	92.0
50% Silt	15.2	14.0	92.0	95.0
75% Silt	16.0	15.0	98.0	95.0

*: Before sowing of gram **: After gram harvesting
O.M. = Organic matter

Results and Discussion

Analysis of variance (Table 2) shows that emergence m^{-2} was not significantly affected by the treatments. Controlled plot (having no groundnut residue) generally had lower emergence m^{-2} (18.7) as compared with rest of the treatments (Table 3). The non-significant effect of the different treatments on emergence m^{-2} could be due to the fact that emergence is dependent upon the endogenous food reserves of the seed, optimum moisture and temperature. Days to flowering were significantly ($p < 0.01$) affected by soil amendments (SA) and groundnut residue (GNR). Comparing the means for soil amendments with groundnut residue it was observed that soil amendments treatment significantly delayed flowering (Table 3). Within soil amendments, gypsum significantly delayed flowering as compared with silt.

Means values of nodules $plant^{-1}$ shows that no groundnut residue (NGNR) had significantly less number of nodules $plant^{-1}$ (2.20) as compared with the mean of the rest of the treatments (9.46 $plant^{-1}$) (Table 3). Similarly, groundnut residue had significantly less nodules (3.40 $plant^{-1}$) as compared with soil amendment (SA), which were 10.48 $plant^{-1}$. Silt treatments indicated a significantly ($p < 0.01$) positive effect on nodules formation (15.13 nodules $plant^{-1}$) while gypsum applications were 5.82

Table 2: Mean Square of yield and yield parameters of gram as affected by soil amendments (SA) with groundnut residue (GNR), silt and gypsum

S.O.V.	d.f	Emergence (m^{-2})	Days to flowering	No. of nodule $Plant^{-1}$	No. of pods $plant^{-1}$	Days to maturity	1000-grains wt. (g)	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Replication	3	577.8	1.78NS	18.55NS	1.27NS	18.11NS	11.46	129930NS	225999NS
SA	7	19.03	1.92**	199.8**	41.252**	9.21**	3.12	42803*	269386**
NGNR VS GNR	1	91.29	3.25*	185.0**	111.6**	25.11**	0.45	272025**	154477**
NGNR VS SA	1	3.42	2.38*	172.0**	34.56*	0.148NS	21.43	7762NS	98411NS
Gypsum VS silt	1	1.5	4.12**	522.6**	6.61NS	15.04**	0.0	7240NS	6885NS
Gypsum linear	1	0.12	0.0NS	00.005NS	1.28NS	2.0*	0.0	231NS	3188NS
Gypsum quadratic	1	3.37	1.5*	21.28NS	88.63**	6.0**	0.0	3197NS	154352NS
Silt linear	1	32.0	1.12NS	492.9**	45.6**	1.15NS	0.0	7812NS	45150NS
Silt quadratic	1	1.5NS	1.04NS	4.86NS	0.18NS	15.1**	0.0	1176NS	6389NS
Error	21	23.28	0.305	8.60	4.77	0.281	35.27	13587	9196

*: $p < 0.05$ **: $p < 0.01$

NS = Non-significant SA = Soil amendments GNR = Groundnut residue NGNR = No groundnut residue

Table 3: Soil amendments and groundnut residue affect on yield and yield parameters of gram

Treatments	Emergence (m^{-2})	Days to flowering	No. of nodule $plant^{-1}$	Pods $plant^{-1}$	Days to maturity	1000-grains wt. (g)	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})
NGNR	18.7	88.5	2.20	23.7	148.7	185.0	278.2	1211
GNR	23.0	88.7	3.40	26.7	151.2	182.5	516.2	1731
Gy.250 kg ha^{-1}	24.2	89.7	4.90	28.8	152.2	185.0	564.5	1837
Gy.500 kg ha^{-1}	23.0	90.5	7.70	34.2	153.2	185.0	604.5	2098
Gy.750 kg ha^{-1}	24.0	89.7	4.85	28.0	151.2	185.0	575.2	1876
Silt 25%	22.0	89.0	7.76	27.0	149.5	185.0	522.0	1804
Silt 50%	24.7	88.7	14.2	29.1	152.2	185.0	532.2	1830
Silt 75%	26.0	89.7	23.45	31.8	150.2	185.0	584.5	1955
LSD (0.01) value	NS	00.81	4.31	03.21	000.78	NS	171.4	547
Rest (2+3+4+5+6+7+8)	23.8	89.4	9.46	29.37	151.4	184.6	557.0	1876
Gypsum (3+4+5)	23.7	89.9	5.82	30.37	152.2	185.0	581.4	1937
Silt (6+7+8)	24.2	89.1	15.13	29.30	150.6	185.0	546.2	1863
Soil amendment (3+4+5+6+7+8)	23.9	89.5	10.48	29.82	151.1	185.0	563.8	1900

Gyp. = Gypsum GNR = Groundnut residue NGNR = No groundnut residue G.Y. = Grain yield

nodules $plant^{-1}$. The response of nodules formation per plant was linear in case of silt and this difference was statistically significant from other soil treatments. It might be due to better aeration in the silt treated plots which provided favorable condition for rhizobium growth. Nyle (1974) reported that aerobic bacteria perform well as nitrogen fixer in well aerated soil.

Number of pods $plant^{-1}$ were significantly ($p < 0.01$) affected by groundnut residue and soil amendments (Table 2). Plots without crop residue had significantly less pods $plant^{-1}$ (23.70) when compared with the means of the rest of the treatment (29.37). Numbers of pods $plant^{-1}$ were also significantly different between groundnut residue and soil amendments (SA). The data showed (Table 3) that soil amendments had 29.82 pods $plant^{-1}$ while the numbers of pods $plant^{-1}$ in groundnut residue were 26.7. Significantly linear trend in pods $plant^{-1}$ with 25% silt to 50% was noticed.

Plant maturity was not significantly affected by groundnut residue and soil amendments (SA) (Table 2). Comparing soil amendments methods it was found that gypsum application had significantly delayed maturity as compared with silt. The delay in maturity with application of gypsum is in an agreement with those reported by Daiz and Cervantes (1990).

Data pertaining to 1000-grains weight (Table 3) showed that grain weight was not significantly affected by groundnut residue and soil amendments.

Grain yield was significantly ($p < 0.01$) lower in groundnut residue (278.2 kg ha^{-1}) as compared with rest of the treatments (557.0 kg ha^{-1}). It may be due to the fact that experimental site is basically clay to clay loam in nature (Table 1) and might have poor aeration and resultantly lower nodule formation. Increase upto 24% in grain yield of cowpea with application of 300 kg ha^{-1} lime have observed by Mathew *et al.* (1985). Rao *et al.* (1986) noticed that increase in yield of groundnut because of the residual effect of 500 kg ha^{-1} gypsum was applied to groundnut crop as compared with the residual effect of 250 kg ha^{-1} of gypsum application. Data regarding biomass yield shows that like grain yield (Table 3) no groundnut residue had significantly lower biomass of 1211 kg ha^{-1} against biomass of the rest of the treatments (1875 kg ha^{-1}). Increase in biomass production in wheat after legumes because of increased nitrogen supply have been reported by Asseng *et al.* (1998) and increase in grain yield in rotating rice after legumes or legumes after legumes have been reported by Veeranna (1987) as compared with rices after rice cropping pattern. Rice *et al.* (1993) and Sparrow (1995) found a significant increase in barley yield following incorporation of annual legumes. These results indicated that in area, where groundnut and gram are grown, gram after groundnut would be good cropping pattern in form of yield, return and its long run positive effect on soil nutrients reserves.

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