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EFFECTS OF WEED CONTROL AND COW DUNG MANURE ON GROWTH INDICES OF QUALITY PROTEIN MAIZE

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ABSTRACT
Field trials were conducted during the 2006, 2007 and 2008 rainy seasons at the Institute for Agricultural Research farm Samaru, in the Northern guinea savanna zone of Nigeria to evaluate the effects of weed control and cow dung manure treatments on growth of quality protein maize. The trials consisted of factorial combinations of eight weed control treatments which include application of proprietary mixtures of (Atrazine + Acetochlor + Terbuthylazine at a ratio of 1:1:1, Atrazine + Metolachlor at a ratio of 1:2 each at 3.0 and 4.0 kg a.i/ha, Atrazine at 4.0 and 5.0 kg a.i/ha, Hoe weeded at 3 and 6 weeks after sowing and a weedy check) with four cow dung manure levels at (0, 4, 8 and 12 t/ha and a recommended NPK mineral fertilizer check at the rate of 120 kg N, 26 kg P and 50 kg K/ha. The treatments were laid out in a split plot design with three replicates. Results indicated that application of Atrazine + Metolachlor at 4.0 kg a.i/ha and the two hoe weeded produced significantly (p>0.05) higher and similar values of 140.2 and 137.3 grams respectively for total dry matter with 11.1 and 11.8 g/m^2/week respectively for crop growth rate. Plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha recorded significantly the highest values of 3.05 for leaf area index and 0.41 for harvest index. Application of Atrazine + Acetochlor + Terbuthylazine at 4.0 kg a.i/ha significantly recorded the highest shoot lodging count. The highest relative growth rate was by plots treated with Atrazine + Metolachlor at 3.0 kg a.i/ha. The weedy check consistently produced the least values for all parameters. Application of cow dung manure at 12 t/ha and the NPK mineral fertilizer check significantly produced the highest values for all parameters while the least were by the 0 fertilizer control. Based on the result of this study it can be concluded that the application of Atrazine + Metolachlor at 4.0 kg a.i/ha and cow dung manure at 12 t/ha significantly increased growth indices of Quality Protein Maize.
Keywords - Weed control, Cow dung manure, Growth indices, Quality protein maize

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important staple food crops in west and central Africa. The savanna zone of west and central Africa has the greatest potential for its production, due to relatively high incidence of solar radiation and lower incidence of pest and diseases during the cropping season (Badu-Apraku *et al.,* 2006). According to Food and Agricultural Organization of the United Nations, 822.7 million metric tonnes of maize were produced worldwide in the year 2008 on 159.5 million hectares. The United States of America produced 333 million metric tonnes, china produced 163 million metric tonnes, Latin America and the Caribbean produced 84 million metric tonnes, Africa produced 53.2 million metric tonnes, while Nigeria produced only 7.5 million metric tonnes (FAO, 2008).

Maize is widely believed to have the greatest potential among food crops for attaining technological breakthroughs that will improve food production in the savanna zone of west and central Africa (Kamara and Sanginga, 2001). Quality Protein Maize (QPM) contains double amounts of lysine and arginine, higher levels of tryptophan and cystein with no change in other amino acids, except lower levels of leucine. The QPM amino acid profile gives a good balance of total essential amino acids, and has an amino acid digestibility score of 67% compared to 28.5, 31.0 and 33% values for pioneer, dent and flint maize respectively (Zakadas *et al.,* 1995). Weed infestation and low soil fertility are the most important factors constraining the production of QPM particularly in the Nigerian savanna zone where it is widely grown (Mahadi *et al*., 2012). Weeds compete with maize for growth resources particularly during the critical period of weed infestation which is between 3 and 6 weeks after sowing in maize thereby depressing growth, development and yield of the crop (Lagoke *et al.,* 1991). In Nigeria, losses of up to 80% in the potential yield of maize had been attributed to unchecked weed growth throughout the crop life cycle (Lagoke *et al.,* 1991). Methods of weed control in maize include manual method which involves hand pulling and use of hoes, mechanical method which involves use of tractors and other mechanical devices and biological methods which involves using an organism to suppress another. These methods of weed control are usually labour intensive, costly and not easily available at the right time of need or require techniques which are beyond the knowledge of local farmers. Consequently chemical method of weed control which involves the use of herbicides is an efficient, effective and economical method which can therefore serve as an alternative weed control method.

Lombin (1987) reported low organic matter content and low cation exchange capacity as characteristic features of Nigerian soils. He further identified nitrogen and phosphorus as the most limiting nutrients in the soil.

In recent times the high cost of inorganic fertilizers and its poor distribution methods have affected its availability to resource poor farmers thereby resulting in the use of insufficient quantities at the time of need which usually contributes to low crop yields. In line with the foregoing an alternative source of crop nutrition such as by the use of cow dung manure can be considered. Cow dung manure is an important resource for crop production and soil nutrient sustainability. It provides an excellent source of organic matter and restores some essential nutrients depleted by the prevailing cropping practices (Bahman and James.1999). To restore and maintain the soil nutrient status for improved crop productivity cow dung manure application can be considered as an option provided it is applied at the right dosage and time. In view of its rich protein content, improved crop husbandry practices aimed at improving the growth and development of the crop such as adequate weed control and crop nutrition will translate to higher yield thereby boosting the production of the crop, this will enhance the nutritional status of the populace by ensuring food security and improving livelihood.

This study was undertaken with the objective of evaluating weed control treatments and cow dung manure to ascertain their influence on growth indices of QPM.

MATERIALS AND METHODS

Field trials were conducted during the 2006, 2007 and 2008 rainy seasons at the research farm of the Institute for Agricultural Research Samaru (11°11'N 07° 38'E and 686 meters above sea level) in the Northern Guinea savanna ecological zone of Nigeria. The physico- chemical properties of the soils at the experimental sites and the cow dung manure used in the trials are presented in Tables 1 and 2 respectively. The crop variety used was SAMMAZ 14, which is late maturing with a yield potential of 5t/ha.

The trials consisted of factorial combinations of eight weed control treatments, which includes application of proprietary mixtures of (Atrazine + Acetochlor + Terbuthylazine at a ratio of 1:1:1, Atrazine + Metolachlor at a ratio of 1:2 each at 3.0 and 4.0 kg a.i/ha, Atrazine at 4.0 and 5.0 kg a.i/ha, Hoe weeded at 3 and 6 weeks after sowing and a weedy check), with four cow dung manure levels at (0, 4, 8 and 12 t/ha and the recommended NPK mineral fertilizer rate of 120 kg N, 26 kg P and 50 kg K/ha to serve as a check for comparison. The weed control treatments were assigned to the main plots while the fertilizer treatments were assigned to the sub-plots. The treatments were laid out in a split plot design with three replications. The gross and net plot sizes were 18 m^2 and 12 m^2 respectively. The experimental site was ploughed, harrowed and ridged at 75cm apart. Cow dung manure was incorporated on treatment basis two weeks before planting.

The seeds were planted on the 19th July 2006, 10th June 2007 and 16th June 2008. Two seeds were sown per hole manually along the ridges at an intra-row spacing of 25cm. After germination seedlings were thinned to one plant per stand at two weeks after sowing. Pre-emergence herbicides were applied immediately after sowing using a Cp3 knapsack sprayer set at a pressure of 2.1kg/m^2. Hoe weeding was carried out at 3 and 6 weeks after sowing for the hoe weeded control in each year of the trial. Inorganic fertilizers were applied by side dressing at the rate of 120 kg N, 26 kg P and 50 kg K/ha to supply the inorganic fertilizer treatment plots. The N was applied in two split doses at 3 and 6 weeks after sowing while the P and K were applied at 3 weeks after sowing using NPK 15:15:15 and Urea 46% N.

Data was collected on leaf area index, total dry matter, crop growth rate, relative growth rate, shoot lodging count and harvest index. Data collected were subjected to analysis of variance as described by Snedecor and Cochran (1967). The treatment means were separated using Duncan's multiple range test (Duncan, 1955).

RESULTS

The soils of the experimental sites were loam and moderately acidic with low N and P, while the Na and CEC were moderate (Table 1). Result of the analyzed dry cow dung samples revealed a high concentration of macro and micro nutrients. Total nitrogen was 2.11, 1.86 and 1.97% in 2006, 2007 and 2008 respectively, available phosphorus was 0.72, 0.64 and 0.67% in 2006, 2007 and 2008 respectively, available potassium was 1.87, 1.73 and 1.82% in 2006, 2007 and 2008 respectively, percentage calcium was 0.52, 0.36 and 0.48 in 2006,2007 and 2008 respectively, magnesium 0.65,0.42 and 0.83% in 2006, 2007 and 2008 respectively and organic carbon 18.2, 26.5 and 23.7% in 2006, 2007 and 2008 respectively (Table 2). It was observed that the manure used in the first year was richer than those used in the preceding years with the second year having the least values for each of the nutrients tested except for organic carbon which was high as indicated above and in Table 2. The herbicide treatments and plots weeded twice produced higher leaf area index (LAI) compared to the weedy check in all the seasons and the mean. In 2006, 2008 seasons and the mean, plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha had the highest LAI values of 3.02, 3.27 and 3.05 respectively while in 2007 season plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha, Atrazine at 5.0 kg a.i/ha and those weeded twice at 3 and 6 weeks after sowing had the highest LAI values of 2.86, 2.79 and 2.91 respectively. The weedy check plots consistently gave the least LAI values of 2.22, 1.98, 1.84 and 2.01 respectively in 2006, 2007, 2008 and the mean (Table 3).

Throughout the seasons and the mean each increase in cow dung rate from 0 – 12t/ha led to a significant increase in leaf area index.

The 12t/ha treatment gave the highest LAI values which were statistically the same to the NPK fertilizer check (Table 3).

Plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha and those weeded twice produced the heaviest total dry matter (TDM) of 138.0 and 140.7 grams/per plant respectively in 2006, 150.3 and 148.9 grams/plant respectively in 2008, 140.2 and 137.3 grams/plant respectively in the mean, however in 2007 season, plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha produced the heaviest TDM per plant which was statistically comparable to those treated with Atrazine + Acetochlor + Terbuthylazine at 4.0 kg a.i/ha., Atrazine + Metolachlor at 3.0 kg a.i/ha and Atrazine at 5.0 kg a.i/ha. The weedy check treatment consistently produced the least TDM per plant throughout the seasons and the mean (Table 3).

Each increase in cow dung manure from the control to 12t/ha led to a significant increase in TDM per plant in all seasons and the mean. The 12t/ha treatment recorded the heaviest TDM of 174.4, 153.0, 170.9 and 166.1 grams respectively in the three seasons and the mean which were comparable to the NPK treatment in 2006 and 2007 seasons (Table 3).

There was a highly significant interaction between weed control and cow dung manure treatments in 2007 season (Table 3a). Holding cow dung at 12t/ha and the NPK mineral fertilizer constant, all the weed control treatments produced similar and heavier TDM and each was superior to the weedy check and Atrazine + Acetochlor + Terbuthylazine at 3.0 kg a.i/ha (Table 3a).

In 2006, 2007 seasons and the mean plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha and those weeded twice recorded significantly higher crop growth rate (CGR) which were statistically similar to plots treated with Atrazine + Acetochlor + Terbuthylazine at 4.0 kg a.i/ha in 2007 season only, however in 2008 season the two hoe weeded recorded the highest CGR. The least CGR was by the weedy check in all the seasons and the mean (Table 4).

Each increase in cow dung from 0 to 12t/ha led to a significant increase in CGR. The 12t/ha recorded the highest CGR which was statistically the same with the NPK mineral fertilizer treatment throughout the seasons and the mean, the 0 control treatment produced the least CGR (Table 4).

A significant interaction between weed control treatments and cow dung manure on crop growth rate was observed in 2006 season (Table 4). Generally with all the weed control treatments each increase in cow dung rate increased CGR of QPM. The highest crop growth rate was by application of Atrazine + Metolachlor at 4.0 kg a.i/ha and the two hoe weeded in conjunction with NPK fertilizer treatment (Table 4a).

In 2006 season, plots that received Atrazine + Metolachlor at 3.0 kg a.i/ha resulted in significantly higher relative growth rate (RGR) than the weedy check but statistically at par to all other weed control treatments.

In 2007, Atrazine + Metolachlor at 4.0 kg a.i/ha and Atrazine at 5.0 kg a.i/ha gave significantly higher RGR than the other treatments but were statistically at par to the two hoe weeded. However, in 2008 season, application of Atrazine + Metolachlor at both rates gave significantly higher RGR than all the other weed control treatments; while in the mean data, Atrazine + Metolachlor at 3.0 kg a.i/ha significantly had higher RGR than Atrazine + Acetochlor + Terbuthylazine at 3.0 kg a.i/ha, Atrazine at 4.0kg a.i/ha and the weedy check which had the lowest RGR throughout the seasons and the mean.

The RGR increased with increasing cow dung from 0 – 12t/ha in 2007, 2008 and the mean and from 0 – 4t/ha in 2006 season (Table 4).

Shoot lodging count was significantly increased by application of Atrazine + Acetochlor + Terbuthylazine and Atrazine Metolachlor each at 4.0 kg a.i/ha in 2006 season, while in 2007 season and the mean, application of Atrazine + Acetochlor + Terbuthylazine at 4.0 kg a.i/ha led to higher shoot lodging count. However, in 2008 application of Atrazine Metolachlor at 4.0 kg a.i/ha had the highest shoot lodging count which was statistically comparable to Atrazine at 5.0 kg a.i/ha (Table 5). Each increase in cowdung rate from 0 – 12t/ha led to a significant increase in shoot lodging count in 2007 season and the mean. However, in 2006 and 2008 seasons each increase in cow dung rate from 0 – 4t/ha and 8 – 12t/ha led to a significant increase in shoot lodging count. The 12t/ha treatment had the highest shoot lodging count which was statistically the same with the NPK fertilizer treatment in 2006, 2008 seasons and the mean (Table 5).

All weed control treatments with the exception of Atrazine at 4.0 kg a.i/ha in 2007 season and the mean, and Atrazine at both rates in 2008, Atrazine + Acetochlor + Terbuthylazine at 3.0 kg a.i/ha in the mean and the weedy check in all the seasons resulted in significantly higher harvest index of QPM.

In 2006 and 2008 seasons, each increase in cow dung rate from 0 – 12t/ha led to a significant increase in harvest index of QPM while in 2007 season and the mean each increase in cow dung manure from 4 – 12t led to a significant increase in harvest index of QPM. The 12t/ha treatment and the NPK fertilizer treatment recorded the highest harvest index of 0.47, 0.37, 0.45 and 0.43 respectively for the 12t/ha treatment across the years and the mean while harvest index values of 0.45, 0.38, 0.45 and 0.43 respectively were recorded across the years and the mean in the NPK treated plots (Table 5).

DISCUSSION

The growth indices of QPM such as leaf area index, total dry matter, crop growth rate and relative growth rate were significantly ($P > 0.05$) affected by the weed control treatments. Plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha throughout the seasons and those weeded twice in 2006, 2008 and the mean resulted in significantly ($P > 0.05$) higher total dry matter of 138.0, 132.5, and150.3 grams per plant in plots treated with Atrazine + Metolachlor at 4.0 kg a.i/ha, across the seasons and 140.7, 148.9 and 137.3 grams per plant in plots weeded twice in both seasons and the mean, while the weedy check produced the least total dry matter of QPM.

The higher dry matter recorded by these treatments could be attributed to less weed competition resulting in better use of available growth factors for maximum photosynthetic activities (Rasheed *et al* 2003). This is in line with the findings of Adekpe (2004) who reported higher total dry matter of garlic with two hoe weeded control and 2.0 kg a.i/ha of Oxadiazon. Leaf area index of QPM was also significantly increased by the application of Atrazine + Metolachlor at 4.0kg a.i/ha throughout the season, Atrazine at 5.0 kg a.i/ha and two hoe weeded in 2006 season. Crops are known to attain better canopy with higher number of leaves per plant in a less weed competitive situation than in a weedy environment (Lagoke *et al.,* 1991). Atrazine + Metolachlor is a mixture of two different herbicides, Atrazine is a broad leaf weed killer while Metolachlor is a grass killer, this might have indefinitely increased the spectrum and efficacy of weed control. Throughout the seasons the herbicide treatments and hoe weeded resulted in higher crop growth rate and relative growth rate of QPM than the weedy check. This could be due to good weed control which allowed crops to develop larger leaves and consequently higher light interception for increased dry matter accumulation per plant per unit area of land. Similar observation was made by Ishaya (2004), who reported lower crop growth rate and relative growth rate by crops in the weedy check and lower rates of oxadiazon.

Application of cow dung manure at 8 and 12t/ha significantly increased total dry matter, leaf area index, crop growth rate, relative growth rates, shoot lodging count and harvest index of QPM. The increase of these parameters as a result of the application of cow dung manure improved availability of nutrients in the soil that were necessary for growth and development in crops (Anon, 2007b). Cow dung manure has also been reported to greatly improve water holding capacity, soil aeration, soil structure, nutrient retention and microbial activity in the soil (Anon, 2007 a).

CONCLUSION

The study concluded that application of Atrazine + Metolachlor at 4.0 kg a.i/ha and cow dung manure at 12t/ha adequately controlled weeds and provided nutrients which increased growth indices and development of Quality Protein Maize.

Table 1: Physico-chemical Properties of Soil Samples from the Experimental Sites at 0 – 15cm

Composition	2006 0 – 15cm	2007 0 – 15cm	2008 0 – 15cm
Physical Properties			
Sand (%)	43	46	41
Silt (%)	38	36	40
Clay (%)	19	18	19
Textural class	Loam	Loam	Loam
Chemical properties			
pH in H_2O (1:2:5)	5.6	5.8	5.7
pH in 0.01m $CaCl_2$ (1:2:5)	5.4	5.7	5.3
Organic Carbon (g/kg)	0.63	0.52	0.48
Total Nitrogen (g/kg)	0.61	0.36	0.68
Available Phosphorus (meq/kg)	13.4	9.8	11.3
Exchangeable Cations (Cmol/kg soil)			
Calcium	1.20	1.00	1.40
Sodium	1.00	1.00	1.20
Potassium	0.58	0.96	0.62
Magnesium	0.64	0.82	0.67
C.E.C	5.80	5.60	5.80

Table 2: Chemical Properties of Cow dung Manure Samples

Chemical composition	2006	2007	2008
Total nitrogen (%)	2.11	1.86	1.97
Available phosphorus (%)	0.72	0.64	0.67
Potassium (%)	1.87	1.73	1.82
Calcium (%)	0.52	0.36	0.48
Magnesium (%)	0.65	0.42	0.83
Organic carbon (%)	18.2	26.5	23.7

Table 3: Effect of weed control treatments and cow dung manure on leaf area index and total dry matter of QPM at Samaru during 2006, 2007 and 2008 rainy seasons and the mean.

Treatments			Leaf Area Index 9 WAS				Total Dry Matter (g) 9WAS			
			2006	2007	2008	Mean	2006	2007	2008	Mean
Weed control	Ratio	Rate (Kg a.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	1:1:1	3.0	2.71bc	2.15d	2.61d	2.49d	86.6c	112.2c	116.9d	105.2c
Atrazine + Acetochlor + Terbuthylazine	1:1:1	4.0	2.52c	2.59b	2.73c	2.61c	119.0b	129.1ab	124.9b	124.3ab
Atrazine + Metolachlor	1:2	3.0	2.59b	2.43bc	2.99b	2.67c	122.3	125.8ab	118.2c	122.1b
Atrazine + Metolachlor	1:2	4.0	3.02a	2.86a	3.27a	3.05a	138.0a	132.5a	150.3a	140.2a
Atrazine		4.0	2.52c	2.32c	2.54e	2.46d	84.4c	109.7c	96.8e	96.9c
Atrazine		5.0	2.67bc	2.79a	2.71cd	2.72b	122.3b	124.2ab	120.9bc	122.4b
Hoe weeding at 3 and 6 WAS			2.72b	2.91a	2.80c	2.81b	140.7a	122.5b	148.9a	137.3a
Weedy check			2.22d	1.98e	1.84f	2.01e	46.1d	60.8d	74.1f	60.3d
SE±			0.06	0.05	0.04	0.05	5.53	2.71	2.39	5.31
Manure (Cowdung)		T/ha								
		0	2.17d	1.67d	2.15d	1.99d	45.1d	53.0d	47.8e	48.6e
		4	2.39c	2.35c	2.41c	2.38c	58.4c	81.7c	74.1d	71.4d
		8	2.67b	2.58b	2.89b	2.71b	120.2b	130.3b	132.2c	127.5c
		12	2.90a	3.01a	3.02a	2.97a	174.4a	153.0a	170.9a	166.1a
NPK		120:26:50	2.98a	2.90a	2.97ab	2.95a	158.2a	154.9a	162.6b	158.5b
SE±			0.04	0.04	0.03	0.02	4.37	2.14	1.89	2.18
Interaction										
W x F			NS	NS	NS	NS	NS	**	NS	NS

Means followed by the same letter(s) within a column of each treatment group are not statistically different at 5% level of probability using DMRT.
WAS – Weeks after sowing, NS - Not significant, W - Weed control, F - Fertilizer

Table 3a: Interaction of weed control treatments and cowdung manure on total dry matter of QPM at 12 WAS during 2007 wet season at Samaru

Treatments			Manure t/ha				NPK
			0	4	8	12	120:26:50
Weed control	Ratio	Rate (Kg a.i/ha)					
Atrazine + Acetochlor + Terbuthylazine	1:1:1	3.0	42.4g	84.3f	142.6c	140.8cd	151.2bc
Atrazine + Acetochlor + Terbuthylazine	1:1:1	4.0	55.4g	93.3e	155.3b	178.0a	163.5a
Atrazine + Metolachlor	1:2	3.0	61.0g	103.9e	123.5d	166.9a	173.6a
Atrazine + Metolachlor	1:2	4.0	66.1g	96.7e	154.7b	167.1a	177.8a
Atrazine		4.0	48.1g	55.4g	127.2d	163.5a	162.7a
Atrazine		5.0	63.3g	96.0e	135.7c	163.2a	163.2a
Hoe weeding at 3 and 6 WAS			57.3g	77.5f	135.8c	175.8a	172.2a
Weedy check			36.5h	46.5g	68.0f	69.3f	83.6f
SE±			6.07				

Means followed by the same letter(s) within a column of each treatment group are not statistically different at 5% level of probability using DMRT.

Table 4: Effect of weed control treatments and cowdung manure on crop growth rate and relative growth rate of QPM at Samaru during 2006, 2007 and 2008 rainy seasons and the mean.

Treatments			Crop Growth Rate(6-9 WAS)				Relative Growth Rate(9WAS)			
			2006	2007	2008	Mean	2006	2007	2008	Mean
Weed control	Ratio	Rate (Kg a.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	1:1:1	3.0	6.6c	7.4d	5.3e	6.4d	0.12ab	0.15c	0.17c	0.15b
Atrazine + Acetochlor + Terbuthylazine	1:1:1	4.0	8.5b	11.1a	7.9d	9.1b	0.14ab	0.17b	0.19b	0.17abc
Atrazine + Metolachlor	1:2	3.0	6.8c	9.2b	10.2c	8.7b	0.20a	0.15c	0.21a	0.19a
Atrazine + Metolachlor	1:2	4.0	10.9a	11.0a	11.5b	11.1a	0.12ab	0.20a	0.21a	0.18ab
Atrazine		4.0	7.2c	8.2c	7.3d	7.5c	0.11ab	0.14c	0.16c	0.14c
Atrazine		5.0	8.7b	9.6b	10.1c	9.4b	0.19ab	0.20a	0.16c	0.18ab
Hoe weeding at 3 and 6 WAS			11.1a	11.6a	12.8a	11.8a	0.13ab	0.19ab	0.16c	0.16abc
Weedy check			3.9d	4.3e	4.0f	4.0e	0.08b	0.10d	0.09d	0.09d
SE±			0.29	0.25	0.26	0.27	0.03	0.09	0.25	0.02
Manure (Cowdung)		T/ha								
		0	2.2d	2.6d	2.5d	2.4d	0.06b	0.09d	0.10e	0.09d
		4	5.5c	4.4c	5.2c	5.0c	0.14ab	0.13c	0.13d	0.13c
		8	8.2b	10.1b	8.4b	8.9b	0.13ab	0.19b	0.19c	0.17b
		12	11.7a	14.1a	13.5a	13.1a	0.17a	0.21a	0.22a	0.20a
NPK		120:26:50	12.2a	14.0a	13.6a	13.2a	0.20a	0.18b	0.20b	0.19ab
SE±			0.23	0.28	0.20	0.19	0.02	0.12	0.15	0.01
Interaction										
W x F			*	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are not statistically different at 5% level of probability using DMRT.
WAS – Weeks after sowing, NS - Not significant, W - Weed control, F - Fertilizer

Table 4a: Interaction of weed control treatments and cowdung manure on crop growth rate of QPM at 12WAS during 2006 wet season at Samara

Treatments			Manure T/ha				NPK
			0	4	8	12	120:26:50
Weed control	**Ratio**	**Rate (Kg a.i/ha)**					
Atrazine + Acetochlor + Terbuthylazine	1:1:1	3.0	1.87i	5.37g	6.47f	10.19cd	9.16de
Atrazine + Acetochlor + Terbuthylazine	1:1:1	4.0	3.63h	7.33f	9.99d	11.70c	10.02d
Atrazine + Metolachlor	1:2	3.0	2.04i	5.71fg	6.22f	9.57d	10.18cd
Atrazine + Metolachlor	1:2	4.0	2.32i	7.15f	10.4d	16.32b	18.86ab
Atrazine		4.0	2.54hi	4.20g	8.25ef	10.77c	10.67cd
Atrazine		5.0	2.24i	6.52f	10.71cd	12.15c	12.26c
Hoe weeding at 3 and 6 WAS			2.25i	6.01f	9.42d	17.37	20.62a
Weedy check			1.45i	2.45i	4.27g	5.54g	6.12f
SE±			0.65				

Means followed by the same letter(s) within a column of each treatment group are not statistically different at 5% level of probability using DMRT.

Table 5: Effect of weed control treatments and cowdung manure on shoot lodging count and harvest index of QPM at Samaru during 2006, 2007 and 2008 rainy seasons and the mean.

Treatments			Shoot Lodging count				Harvest Index			
			2006	2007	2008	Mean	2006	2007	2008	Mean
Weed control	Ratio	Rate (Kg a.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	1:1:1	3.0	6.6c	7.6c	3.5c	5.9d	0.37a	0.33ab	0.40ab	0.29b
Atrazine + Acetochlor + Terbuthylazine	1:1:1	4.0	12.3a	10.0a	4.7b	9.0a	0.40a	0.32ab	0.41ab	0.37ab
Atrazine + Metolachlor	1:2	3.0	10.2b	4.8d	4.5b	6.5cd	0.39a	0.31ab	0.43a	0.37ab
Atrazine + Metolachlor	1:2	4.0	11.9a	6.5c	6.0a	8.1b	0.42a	0.36a	0.44a	0.41a
Atrazine		4.0	7.2c	8.8b	4.1b	6.7c	0.37a	0.26b	0.32c	0.31c
Atrazine		5.0	7.3c	5.9c	5.0ab	6.0d	0.41a	0.32ab	0.36b	0.35ab
Hoe weeding at 3 and 6 WAS			1.5d	1.6f	1.0d	1.4e	0.40a	0.20ab	0.42a	0.34ab
Weedy check			2.0d	2.2e	1.6d	1.9e	0.30b	0.18c	0.15e	0.21d
SE±			0.36	0.29	0.44	0.36	0.01	0.01	0.01	0.01
Manure (Cowdung)		T/ha								
		0	6.0c	3.0e	1.7c	3.5d	0.26d	0.20c	0.21d	0.22c
		4	6.9b	4.5d	2.2b	4.5c	0.30c	0.17c	0.26c	0.24c
		8	7.0b	6.3c	2.6b	5.3b	0.43b	0.27b	0.37b	0.36b
		12	8.7a	8.4a	6.7a	7.6a	0.47a	0.37a	0.45a	0.43a
NPK		120:26:50	8.3a	7.4b	6.8a	7.5a	0.45a	0.38a	0.45a	0.43a
SE±			0.28	0.23	0.35	0.28	0.01	0.01	0.01	0.01
Interaction										
W x F			NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are not statistically different at 5% level of probability using DMRT.
WAS – Weeks after sowing
NS - Not significant
W - Weed control
F - Fertilizer

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