Effect of Integrated Weed Management on Growth, Yield, Yield Attributes and Economics of Grain Amaranth (*Amaranthus hypochondriacus* L.) under South Gujarat Condition

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**Abstract**

Field experiment was conducted on dark brown soil of the college farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during rabi season of 2016-2017 to study the effect of integrated weed management on growth, yield, yield attributes and economics of grain amaranth (*Amaranthus hypochondriacus* L.) Production potential, higher profit and effective weed control in grain amaranth can be achieved by maintaining weed free through hand weeding throughout crop growth period, where labours are easily available. In case of labours scarcity, application of oxyfluorfen 50g/ha PE fb fenoxy prop ethyl 50g/ha PoE at 40 DAS also equally effective.

**Keywords**
Grain amaranth, Weed management, Economics, Oxyfluorfen, Oxadiargyl, Fenoxy prop ethyl

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**Introduction**

Amaranths is one of the few C₄ crop species other than grasses. Amaranth is a quick growing multipurpose crop suitable for poor soils of semi-arid and seasonal wet areas. This crop is highly resistant to extreme stress conditions.

Grain amaranth (*Amaranthus hypochondriacus* L.) is a potential upcoming subsidiary food crop, considered by many as crop of the future. Green leaf of amaranth is used as vegetable for human being and fodder for animals. The grains of this crop are used in quality human diet. Protein content in grains varies from 11-13 % and the quality of protein is equivalent to fish protein. It is observed that seeds of *A. cruentus* L. *A. hypochondriacus* L. contained higher crude protein (16.86 %), moisture (11.88 %), crude fat (4.30 %), crude fibre (2.90 %), ash (2.10 %), carbohydrates (63.13 %), calcium (169.63 mg/100 g), iron (10.42 mg/100 g), phosphorus (395.33 mg/100 g) (Munjal *et al.*, 1999). Medicinal point of view the amaranth is also important. The tocopherol fraction of amaranth oil contains important cholesterol lowering agents, some
of which could be useful in treating cardiovascular disease. Amaranth grain can be used as popcorn, making sweets, biscuits, pastry etc.

There are several factors responsible for retarding the production and productivity of grain amaranth. Among which, weed infestation is reported to cause yield losses. Yield losses due to weed competition vary considerably depending on the level of weed infestation and weed species prevailing. Nevertheless, almost all values reflect the seriousness of the weed problem.

Besides, weeds consume more labours, as well as increase the cost of production. However, recently the adopting of integrated weed management, inclusive application of herbicide and cultural practices has been found more effective in control of weeds (Arya, 2004).

Materials and Methods

An experiment was conducted on College Farm, Navsari Agricultural University, Navsari during rabi season of 2016-17. Twelve treatments comprising of weed management practices viz., T1: Weed Free, T2: One hand weeding at 20 DAS, T3: Two hand weeding at 20 DAS and 40 DAS, T4: Oxyfluorfen 50 g/ha PE, T5: Oxadiargyl 50 g/ha PoE at 20 DAS, T6: Fenoxyl prop ethyl 50 g/ha PoE at 20 DAS, T7: Oxyfluorfen 50 g/ha PE fb Oxadiargyl 50 g/ha PoE at 40 DAS, T8: Oxyfluorfen 50 g/ha PE fb Fenoxyl prop ethyl 50 g/ha PoE at 40 DAS, T9: Oxyfluorfen 50g/ha PE + One hand weeding at 40 DAS, T10: Oxadiargyl 50 g/ha PoE, 20 DAS + One hand weeding at 40 DAS, T11: Fenoxyl prop ethyl 50 g/ha PoE, 20 DAS + One hand weeding at 40 DAS, T12: Weedy check; were evaluated in randomized block design with three replications. The soil of the experimental field was clayey in texture, low in available nitrogen (191 kg/ha) and medium in available phosphorus (32 kg/ha), fairly rich in available potash (358 kg/ha), slightly alkaline in reaction (pH 7.9) and having well drainage with good moisture retention capacity. The Grain amaranth cv. G A 2 was sown on 21st November, 2016 and harvested on 29th February 2017.

The crop was fertilized with 60 kg N and 40 kg P2O5/ha. Observation regarding to the growth parameters i.e. plant height (cm) at 30 DAS, 60 DAS and at harvest, Length of main inflorescence (cm), Number of lateral spikelets per spike. Observation regarding to yield and yield attributes i.e. test weight (g/cc), grain and stover yield (kg/ha) and harvest index. The data were analyzed procedures described by Panse and Sukhatme (1985).

Results and Discussion

Effect of weed management on growth parameters

It is evident from the data presented in (Table 1) that the initial as well as at harvest plant population was not influenced significantly by various weed management treatments. Further, the results indicated that there was no adverse effect on germination and establishment of grain amaranth crop due to pre and post emergence application of herbicides during the course of investigation.

Data shows that the significantly higher plant height (68.6 and 183.3 cm) was observed under T1 (weed free) which was statistically at par with treatment T8, T3, T7 and T10 at 60 DAS and at harvest, respectively and At 30 DAS, plant height fails to reach at significantly level due to different weed management treatment. The significantly lower plant height (53.1 and 154.4 cm) was recorded under T12 (weedy check) at 60 DAS
The increase in plant height at periodical growth stage under weed free condition during critical crop competition period might be due to effective control of weeds under these treatments, which improved growth of crop and checked nutrients drain by weeds.

The shortest plant height might be due to severe competition by weeds for moisture and nutrients; consequently, the plant growth was affected. Significant improvement in growth characters also might be due to increase water and nutrient uptake, which might have accelerated photosynthetic rate, thereby increasing the supply of carbohydrates, resulted in increased cell division, multiplication and elongation leading to increase the higher plant growth.

Treatment T1 (weed free) proved better than other herbicides as well as weedy check. Suppressed weed allowed more light, moisture, nutrients and space to crop plant, which resulted in better growth characters. Similar results were also reported by Singh et al., (2017) and by David (1997)

**Effect on yield and yield attributes**

The entire yield attributes namely Length of main inflorescence (cm), number of lateral spikelets per spike, grain yield (kg/ha), stover yield (kg/ha), harvest index (%) and test weight showed significant response to weed management practices but harvest index (%) (Table 2). The significantly longer main inflorescence (84.28 cm) was recorded in treatment T1 (weed free) which was statistically at par with treatment T8, T3, T7, T10, T6, and T11 at harvest. The weed control treatments failed to exert its significant effect on Number of lateral spikelets per spike and harvest index. The higher test weight value (0.90 g/cc) observed under treatment T1 (weed free) which was statistically at par with treatment T8, T3 and T7. Numerically maximum number of lateral spikelets per spike and harvest index was observed under weed free treatment while minimum in weedy check treatment. The higher grain and stover yield (1296 and 3156 kg/ha) was recorded under the weed free treatment (T1).

The treatment T8 in which pre emergence application of Oxyfluorfen 50 g/ha fb post emergence application of Fenoxyl prop ethyl 50 g/ha at 40 DAS was at par with T3, T9, and T11. The magnitude of increase in grain yield under treatment T1 was to the tune of 57.09 % over weedy check (T12), while 54.69 % in T8, 50.40 % in T3 and 45.05 % increase in T11 over weedy check. The per cent increase in stover yield due to weed free condition (T1) was to the tune of 54.24 % over weedy check (T12), while 52.84 % increase in T8, 49.80 % increase in T3, 43.76 % increasing in T9 and 42.49 % increase in T11 over unweeded treatment (T12).

The reason for the increase in grain yield was mainly due to weed free condition provided at critical crop weed competition period, which might be due to effective control of weeds under these treatments. Grain yield is primarily a function of accumulation of photosynthates resulted in growth and increase yield attributes. Therefore, it can be inferred that significant improvement in these parameters contributed towards higher grain yield. The yield loss study also shows that reduced weed population initially by pre-emergence herbicide followed by weed control around 25 to 30 DAS either by post emergence herbicide or hand weeding has less reduction in yield. This result indicated that appreciable increase in grain and stover yield could be the significant improvement in plant growth in terms of plant height under those treatments. Similar effect was also reported by Patel et al., (2012), Shukla et al., (2014) Gaharwar et al., (2017).
Table 1: Effect of weed management on growth parameters of grain amaranth

| Treatment | Plant population per net plot area | Plant height (cm) |
|-----------|------------------------------------|-------------------|
|           | Initial (30 DAS) | At harvest | 30 DAS | 60 DAS | At Harvest |
| **T1**    | Weed free          | 269.9       | 264.2  | 23.43  | 68.6      | 183.3      |
| **T2**    | One hand weeding at 20 DAS        | 275.1       | 268.2  | 22.33  | 57.3      | 159.8      |
| **T3**    | Two hand weeding at 20 DAS and 40 DAS | 280.3   | 273.6  | 23.34  | 67.4      | 180.1      |
| **T4**    | Oxyfluorfen 50g/ha PE             | 267.6       | 261.7  | 22.41  | 56.0      | 159.5      |
| **T5**    | Oxadiargyl 50g/ha PoE at 20 DAS   | 277.7       | 271.6  | 21.35  | 53.4      | 158.5      |
| **T6**    | Fenoxy prop ethyl 50g/ha PoE at 20 DAS | 278.7  | 271.7  | 22.47  | 59.0      | 161.0      |
| **T7**    | Oxyfluorfen 50g/ha PE fb Oxadiargyl 50g/ha PoE at 40DAS | 258.9 | 253.3  | 21.15  | 63.4      | 169.7      |
| **T8**    | Oxyfluorfen 50g/ha PE fb Fenoxy prop ethyl 50g/ha PoE at 40 DAS | 261.8 | 254.1  | 23.54  | 68.3      | 182.5      |
| **T9**    | Oxyfluorfen 50g/ha PE + One hand weeding at 40 DAS | 268.7 | 262.0  | 22.83  | 54.2      | 159.1      |
| **T10**   | Oxadiargyl 50g/ha PoE, 20 DAS + One hand weeding at 40 DAS | 277.6 | 271.3  | 22.31  | 61.5      | 163.4      |
| **T11**   | Fenoxy prop ethyl 50g/ha PoE, 20 DAS + One hand weeding at 40 DAS | 283.8 | 277.8  | 21.56  | 57.5      | 160.5      |
| **T12**   | Weedy check            | 269.1       | 262.9  | 21.76  | 53.1      | 154.4      |
| **S.Em. ± C.D at 5 % C.V. %** | 5.11 | 3.25 | 5.39 | 3.51 | 1.20 | 9.28 | 2.55 | 7.95 | 6.72 | 7.01 |

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Table 2: Effect of weed management on yield parameters and economics of grain amaranth

| Treatment                                           | Test weight (g/cc) | Yield (kg/ha) | Cost of cultivation (₹/ha) | Gross returns (₹/ha) | Net returns (₹/ha) | B:C Ratio |
|-----------------------------------------------------|--------------------|---------------|----------------------------|----------------------|---------------------|------------|
|                                                     | Grain | Stover |                                |                      |                     |            |
| T1 Weed free                                        | 0.90  | 1296  | 3156                           | 17784                | 78409               | 60625      | 3.40       |
| T2 One hand weeding at 20 DAS                       | 0.71  | 874   | 2269                           | 16360                | 52898               | 36538      | 2.23       |
| T3 Two hand weeding at 20 DAS and 40 DAS            | 0.87  | 1121  | 2877                           | 17072                | 67834               | 50762      | 2.97       |
| T4 Oxyfluorfen 50g/ha PE                            | 0.66  | 919   | 2412                           | 14996                | 55593               | 40597      | 2.70       |
| T5 Oxadiargyl 50g/ha PoE at 20 DAS                  | 0.62  | 849   | 2111                           | 14593                | 51385               | 36792      | 2.52       |
| T6 Fenoxy prop ethyl 50g/ha PoE at 20 DAS           | 0.75  | 973   | 2459                           | 15549                | 58862               | 43313      | 2.78       |
| T7 Oxyfluorfen 50g/ha PE fb Oxadiargyl 50g/ha PoE at 40DAS | 0.85 | 825   | 2072                           | 15115                | 49895               | 34780      | 2.30       |
| T8 Oxyfluorfen 50g/ha PE fb Fenoxy prop ethyl 50g/ha PoE at 40 DAS | 0.88 | 1227  | 3062                           | 16071                | 74242               | 58171      | 3.61       |
| T9 Oxyfluorfen 50g/ha PE + One hand weeding at 40 DAS | 0.63 | 1048  | 2568                           | 17132                | 63403               | 46271      | 2.70       |
| T10 Oxadiargyl 50g/ha PoE, 20 DAS + One hand weeding at 40 DAS | 0.78 | 862   | 2185                           | 16729                | 52141               | 35412      | 2.11       |
| T11 Fenoxy prop ethyl 50g/ha PoE, 20 DAS + One hand weeding at 40 DAS | 0.75 | 1012  | 2511                           | 17685                | 61243               | 43558      | 2.46       |
| T12 Weedy check                                     | 0.59  | 556   | 1444                           | 14224                | 33964               | 19740      | 1.38       |
| S.Em. ± C.D at 5 %                                  | 0.03  | 69.61 | 154.74                        | -                    | -                   | -          |
| C.V. %                                               | 0.08  | 217   | 482                            | -                    | -                   | -          |
|                                                      | 6.21  | 12.51 | 11.04                          | -                    | -                   | -          |

Sale price of grain amaranth 1. Grain - ₹ 60/kg 2. Stover - ₹ 0.20/kg
Economics

Economics is the major consideration of farmers, while taking a decision regarding the adoption of the recently developed new technology. Hence the gross realization, net realization and benefit cost ratio were computed for different weed management treatments. Data presented in (Table 2) revealed that maximum gross returns and net return of (78409/ha and 60625/ha) was realized under the treatment T₁ (weed free), followed by treatment T₈ (74242/ha and 58171/ha) and T₃ (67834/ha and 50762/ha). The higher grain yields recorded under these treatments might be responsible for higher gross return. However, the maximum B: C ratio (3.61) was accrued under the treatment T₈ followed by T₁. The lowest gross return, net return and B: C was accrued under the treatment T₁₂ (33964/ha, 19740/ha and 1.38 respectively). So higher gross returns along with the lowest cost under T₁, T₈, T₃ treatments might be responsible for higher net return and B: C ratio. These findings are in close vicinity with those reported by Patel et al., (2012), Shukla et al., (2014), Gaharwar et al., (2017).

Based on results of the field experiment, it seems quite logical to conclude that production potential, higher profit and effective weed control in grain amaranth can be achieved by maintaining weed free through hand weeding throughout crop growth period, where labours are easily available. In case of labour scarcity, application of oxyfluorfen 50g/ha PE fb fenoxyl prop ethyl 50g/ha PoE at 40 DAS, also equally effective.

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