To discuss the effect of various type of weed control practices on crop growth and yield of upland rice

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Abstract

In the present work the object of experiment is to “study the efficacy of different weed control methods and to evaluate the most suitable and economical weed management practice for controlling weeds in upland rice adopted to achieve different agronomic practices” weed management practices with it included seed treatment, fertilizer scheduling and intercropping along its include achieve to for avoidance of weed occurrence, suppression of weed growth and enhancement of crop-competitive ability against weed. The experiment was laid out in randomized block design with three replications and nine treatments. The net plot size was 3.50 x 2.60 m². The experimental soil was slightly alkaline with sandy clay loam texture.

Weed population at 60 DAS and at harvest to dry matter were significantly lower in weed-free check followed by two hand weeding at 20 and 40 DAS, respectively. It was followed by butachlor pre-emergence application 50% EC @ 1.25 kg a.i. per ha + hand weeding at 40 DAS. Maximum dry matter of weed and weedy check observed in weed population. The measured growth of rice in terms of height, number of functional leaves, leaf area plant⁻¹ and dry matter accumulation per plant was favorably influenced by weed-free check and 20 and 40 DAS at two hand weeding. It was followed by application pre-emergence of butachlor 50% EC @ 1.25 kg a.i. per ha + hand weeding at 40 DAS. Similarly trend was observed in contributory character namely respect of yield. Number of panicles per m², Number of grains per panicles, Grain weight per plant and 1000 grain weight i.e. test weight (g)

The highest in weedy check treatment was NPK uptake by weeds (9.05, 3.18and 11.27 kg NPK per ha respectively.) and weed-free treatments lowest in (1.62, 0.407 and 1.687 kg NPK per ha respectively). It was followed by two hand weeding at 20 DAS & 40 DAS respectively (1.41, 0.537 and 2.160 kg NPK per ha respectively) followed by pre-emergence application of butachlor 50% EC @ 1.25 kg a.i. per ha + hand weeding at 40 DAS (2.16, 0.66 and 2.53 kg NPK per ha respectively.) The weed-free check maximum gross monetary return was observed in (Rs.126378 per ha) followed by two hand weeding at 20 DAS & 40 DAS, respectively (Rs.120778 per ha).

Keywords: Weed management, dry matter, hand weeding, application, treatment, weed intensity

Introduction

Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planet’s human population. In world, rice has occupied an area of 156.7 million hectares, with a total production of 650.2 million tonnes in 2007 (FAO, 2008). In Asian countries, rice is the main major staple crop covering about ninety per cent of rice grown in the world, with two countries, China and India, growing more than half of the total crop. India the second largest producer after China has an area of over 43.77 million hectares under rice and production 96.43 million tonnes of rice in 2008 (Viraktamath and Shobharani, 2009). Rice being the main source of livelihood for more than 120 – 150 million rural household is the backbone of the Indian Agriculture. It occupies about 23.3 per cent of the total rice crop area of India covering 43.38 million ha area and accounting to 93.88 million tonnes of production (Anonymous, 2015-16). The conventional system of rice production i.e. transplanting under puddled conditions (CT-TPR) is mainly followed by farmers.

Rice is cultivated in India in a very wide range of ecosystems from irrigated to shallow lowlands, mid-deep lowlands, deep water to uplands.
Direct-seeding constitutes both wet- and dry seeding and it does away with the need for seedlings, nursery preparation, uprooting of seedlings and transplanting. Upland rice, which is mostly dry-seeded, is found in parts of Assam, Bihar, Chhattisgarh, Gujarat, Jharkhand, Kerala, Karnataka, Uttar Pradesh, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. The upland rice area is about 5.5 million hectares which accounts to 12.33% of the total rice area of the country. Wet-seeded rice (WSR) area is increasing in the parts of Andhra Pradesh, Punjab and Haryana. In the rice agro-ecosystems ideal environment conditions are provided for optimal rice productivity are being exploited by the associated weeds.

Weeds are responsible for heavy rice yield losses, to the extent of complete crop loss under extreme conditions. Out of the losses due to various biotic stresses, weeds are known to account for nearly one third. Weed competition would be less severe under transplanting than those under direct-seeding. Uncontrolled weeds reduced the grain yield by 75.8%, 70.6% and 62.6% under dry-seeded rice (DSR), wet seeded rice (WSR) and transplanted rice (TPR) respectively (Singh et al., 2005) [1]. Experiments showed that yield losses are comparable across all establishment methods of rice when competition from weeds was removed. Thus, weed control is major prerequisite for improving rice productivity and production using different methods of rice establishment.

The agricultural growth rate has slowed down (2013-2014 reported less than 2%) in India (Government of India, 2010) Therefore it is needed to produce additional rice production to meet the demand of growing population. Thus weed management would continue to play a key role to meet the growing demands of increasing population in India. As the weed problems are multi-pronged, a holistic multi-disciplinary integrated approach would be imperative. In this context, integrated weed management (IWM) may provide a more sustainable approach to rice production.

**Material and Method**

A field experiment was conducted investigate study the efficacy of different weed control methods and to evaluate the most suitable and economical weed management practice for controlling weeds in upland rice adopted to achieve different agronomic practices

**Material**

1. **Experimental site**

The field experiment was carried out during Kharif season of 2016 at the Agronomy Farm, College of B.F.I.T, Suddhuwala, Dehradun.

2. **Soil of the experimental field**

The soil was vertisol (medium black) in nature and about one metre deep with good drainage. The topography of experimental field was fairly uniform and levelled. The collected Soil samples from 0-15 cm depth and 15 randomly selected spots in the experimental area.

3. **Climate and Weather condition during crop period**

Climatic Study in Suddhuwala, Dehradun shivalik is classified as slightly moist cool zone. college Suddhuwala, Dehruan lies in the Tarai region to the south of foot hills of the Shivalik Himalayas at 29° N latitude, 79.23°E longitude and at an altitude of 243.8 m above mean sea level. The average annual rainfall of dehradun is 1057mm out of which 80 per cent receive from south west monsoon in June to September while rest of rainfall receive in the month of October and November from north west monsoon. The meteorological data of rainfall, temperature, relative humidity, sunshine and potential evapo-transpiration (PET) from July 2016 to November 2016 are furnished in table.

| M.W. No. | Month  | Period       | Temp. 0 c | R.H. (%) | Evap (mm/Day) | R.F. mm | Rainy days |
|----------|--------|--------------|-----------|----------|---------------|--------|------------|
|          |        |              | Max       | Min      | Morn          | Even.  |            |
| 24       | June   | 10/06 to 16/06 | 27.2      | 21.4     | 89            | 81     | 6.5        | 20.5      | 1         |
| 25       |        | 17/06 to 23/06 | 26.2      | 20.2     | 90            | 82     | 5.5        | 55.2      | 2         |
| 26       |        | 24/06 to 30/06 | 25.7      | 20.5     | 92            | 72     | 4.3        | 100.5     | 4         |
| Average  |        |              | 26.3      | 20.7     | 90.3          | 78.3   | 5.4        |           |           |
| 27       | July-Aug | 01/07 to 07/07 | 25.6      | 21.9     | 96            | 82     | 3.2        | 157.6     | 6         |
| 28       |        | 08/07 to 14/07 | 24.8      | 20.6     | 95            | 91     | 4.1        | 105.8     | 6         |
| 29       |        | 15/07 to 21/07 | 24.7      | 20.2     | 96            | 92     | 2.9        | 160.5     | 6         |
| 30       |        | 22/07 to 28/07 | 24.6      | 20.4     | 97            | 90     | 2.8        | 165.5     | 7         |
| 31       |        | 29/07 to 04/08 | 25.3      | 20.7     | 94            | 88     | 3.9        | 162.5     | 6         |
| Average  |        |              | 25.0      | 20.8     | 95.6          | 88.6   | 3.3        |           |           |
| 32       | Aug-Sep | 05/08 to 11/08 | 27.1      | 17.5     | 93            | 78     | 3.5        | 150.5     | 5         |
| 33       |        | 12/08 to 18/08 | 24.6      | 20.6     | 92            | 80     | 3.8        | 105.5     | 4         |
| 34       |        | 19/08 to 25/08 | 26.8      | 20.2     | 90            | 74     | 3.9        | 115.5     | 5         |
| 35       |        | 26/08 to 01/09 | 27.2      | 19.8     | 88            | 64     | 3.7        | 120.6     | 5         |
| Average  |        |              | 26.4      | 19.5     | 90.7          | 74     | 3.7        |           |           |
| 36       | Sep    | 02/09 to 08/09 | 29.2      | 19.6     | 84            | 63     | 3.8        | 100.8     | 3         |
| 37       |        | 09/09 to 15/09 | 29.4      | 21.8     | 89            | 71     | 3.6        | 125.5     | 4         |
| 38       |        | 16/09 to 22/09 | 27.3      | 21.7     | 87            | 81     | 4.6        | 60.6      | 2         |
| 39       |        | 23/09 to 29/09 | 28.3      | 19.7     | 86            | 72     | 5.1        | 45.5      | 2         |
| Average  |        |              | 28.5      | 20.7     | 86.5          | 71.7   | 4.2        |           |           |
| 40       | Oct-Nov | 30/09 to 06/10 | 30.7      | 20.3     | 84            | 67     | 6.2        | 22.6      | 2         |
| 41       |        | 07/10 to 13/10 | 31.7      | 22.5     | 80            | 59     | 8.9        | 20.5      | 1         |
| 42       |        | 14/10 to 20/10 | 31.6      | 21.6     | 78            | 49     | 8.5        | 5.7       | 0         |
| 43       |        | 21/10 to 27/10 | 31.4      | 20.9     | 85            | 48     | 8.6        | 25.5      | 2         |
| 44       |        | 28/10 to 03/11 | 32.3      | 21.5     | 79            | 47     | 7.5        | 0.0       | 0         |
| Average  |        |              | 31.5      | 21.3     | 81.2          | 54     | 7.9        |           |           |
| 45       | Nov    | 04/11 to 10/11 | 31.2      | 22.5     | 78            | 46     | 6.5        | 0.0       | 0         |
| Average  |        |              | 31.2      | 22.5     | 78            | 46     | 6.5        |           |           |
| Total    |        |              |           |          |               |        | 1826.9     | 77        |
The rainfall distribution was normal up to first week of September. In general, the climatic conditions were quite favorable for the growth of paddy crop.

Methods
The experimental detail in along with symbols used and layout of plan are as given in

Field Preparation
Field preparation was made by cross ploughing of tractor-drawn cultivator followed by planking. After this, the experiment layout was done.

Treatment Details
T1: Weedy check
T2: Pendimethalin @ 1.0 kg a.i. per ha as pre emergence + Hand weeding at 40 DAS
T3: Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + Hand weeding at 40 DAS
T4: Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4-D (Sodium salt) @1.0 kg a.i. per ha. at 30 DAS
T5: Hand weeding at 20 DAS + 2, 4-D (Sodium salt) @1.0Kg a.i. per ha at 30 DAS
T6: Hoeing at 20 DAS + hand weeding at 30 DAS
T7: Hand weeding at 20 DAS + Hoeing at 40 DAS
T8: Two hand weedicings at 20 DAS & 40 DAS respectively
T9: Weed Free check (3 weedicings at 20,40 and 60 DAS)

Note: Where as

1. DAS: Days After Sowing
2. A.I.: Active Ingredient

The experiment was laid out in Randomized Block Design with three replications and nine treatments. In Replications-Three, Treatment –Nine, Season –Kharif, Design - Randomized Block Design (RBD), Plot size -Gross: 4.0 m × 3.15 m. Net: 3.50 m × 2.60 m.

Spacing -2.5 cm row to row (line sowing), Variety - Pant Dhan 4, Date of sowing - 15.06.2016, Fertilizer application - 110 kg N + 60 kg P₂O₅ + 50 kg K₂O per ha.

In prepare tillage in field was ploughed with tractor drawn mould board plough. The harrowing was carried out with tractor drawn harrow and stubbles were removed. The experiment was lay out in Randomized Block Design with three replication. The treatment consist of nine weed management in sub plot treatment Small bunds were raised around each plot.

In seeds and sowing in Paddy seed use variety ‘Pant Dhan 4’ were treated with carbenazim @ 2 g kg⁻¹ seed. This variety matures within 128 to 130 days and yields about 55-60 q per ha. Sowing was performed on 15th June, 2016 by manually (line sowing) after basal application of fertilizer using seed rate of 100 kg ha⁻¹. The seed was sown 2 to 3 cm deep by manual labors and was covered with soil.

The recommended doses of fertilizer application in paddy crop N, P₂O₅ and K₂O i.e. 110:60:50 kg ha⁻¹ was applied through urea, single super-phosphate and muriate of potash, respectively. The desired plant population per plot was maintained by gap filling at 7 DAS.

In application of herbicide in The required quantity of spraying of pre-emergence herbicides viz, Pendimethalin @ 1.0 kg a.i. per ha in T2 and T2 treatments and butachlor 50% EC @ 1.25 kg a.i. per ha in T3 treatment were done three DAS i.e. Pendimethalin @ 3.33 lit. per ha and butachlor @ 2.5 lit. per ha were dissolved in 500 lit. of water and sprayed by using knapsack sprayer with flat fan nozzle on soil surface.

Result and Discussion
To presented the data in revealed that at Effect of weed control measures At to use of the treatment pre-emergence pendimethalin @ 1.0 kg a.i. application apply in starting time to reduce the 20 DAS the weed density, as pre-emergence + hand weeding at 40 DAS, butachlor 50% EC @ 1.25 Kg a.i. per ha emergence + hand weeding at 40 DAS, Pendimethalin @1.0 Kg a.i. per ha as pre emergence followed by 2,4-D (Sodium salt) @ 1.0 Kg a.i. per ha at 30 DAS which was significantly superior over all remaining weed control measures. Lowest weed intensity was observed in weed free check followed by, hoeing at 20 DAS + hand weeding at 30 DAS. At 60, 80 and 100 DAS significantly lowest weed intensity was observed in weed free check which was followed by two hand weedicings at 20 DAS & 40 DAS, respectively. Followed by butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + hand weeding at 40 DAS and pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + hand weeding at 40 DAS respectively.

Growth study in rice growth measured in terms of height, functional leaves, leaf area per plant and dry mater accumulation per plant was favorably influenced by weed free check and two hand weedicings at 20 and 40 DAS. It was followed by pre-emergence application of butachlor 50% EC @ 1.25 Kg a.i per ha + hand weeding at 40 DAS. Rice Plants in weed free check achieved maximum height (85.56 cm) at harvest, number of functional leaves (22) at 80 DAS and also maximum dry matter per plant (24.86 g) at harvest.

The Effect of weed control measures The Mean height of 20 DAS plant was not influenced significantly by different weed control measures. The plant height at 40, 60, 80, 100 DAS

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and at harvest was influenced significantly by different weed control treatments. The weed free check treatment recorded the highest plant height at each stage of observation. However it was at par with the treatment two hand weedings 20 and 40 DAS at 60 and 80 DAS respectively. At harvest the weed free treatment recorded significantly more plant height (85.56 cm) as compared to other treatment under study. The weedy check treatment recorded significantly lower plant height at harvest (75.83 cm) as compared to other treatment which indicating that weeds reduces the plant height due to competition. Similar results were recorded by Jadhav et al., 2010 [6].

The data pertaining to the grain and straw yield as affected by weed control measures are presented in Data showed that the average yield of grain and straw 59.74, 85.89 q/ha obtained in Weed free check, followed by two hand weedings at 20 DAS and 40 DAS respectively (73.52 q/ha) and the next best treatment was butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + hand weeding at 40 DAS (65.71), Hoeing at 20 DAS + hand weeding at 30 DAS (61.44 q/ha), followed by Hand weeding at 20 DAS + 2,4-D (Sodium salt) @ 1.0 Kg a.i. per ha as pre-emergence + hand weeding at 20 DAS (63.17). Hoeing at 20 DAS + hand weeding at 30 DAS (73.33 q/ha), Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4-D (Sodium salt) @ 1.0 Kg a.i. per ha at 30 DAS (52.53 q/ha).

Lowest grain yield was recorded in weedy check (21.71 q/ha) Thus weed control the effective achieved in the earlier mentioned treatment resulted in enhancing various growth and yield attributing character of rice and gave significantly higher yield over weedy check. The weed free check, treatments two hand weeding at 20 DAS and 40 DAS and butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + hand weeding at 40 DAS recorded the grain yield 76.96 q per ha/73.52 q/ha and 71.96 q/ha per ha. These results are in conformity with Jadhav et al. (2010) [6] and Sharma et al. (2007) [4].

The significantly straw yield was influenced due to various treatment. Significantly highest straw yield (109.45 q/ha) was obtained in weed free check and it was followed by two hand weeding at 20 DAS and 40 DAS respectively (104.38 q/ha). The next best treatment for producing straw yield was butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + hand weeding at 40 DAS. Further pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + hand weeding at 40 DAS (100.27 q/ha), Hoeing at 20 DAS + hand weeding at 30 DAS (84.33 q/ha), followed by Hand weeding at 20 DAS + 2,4-D (Sodium salt) @ 1.0 Kg a.i. per ha at 30 DAS (73.33 q/ha), Hoeing at 20 DAS followed by Hoeing at 40 DAS (77.33 q/ha). Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4-D (Sodium salt) @ 1.0 Kg a.i. per ha at 30 DAS (81.22 q/ha). Lowest straw yield was recorded in weedy check (41.39 q/ha). These results are in conformity with Sharma et al. (2007) [4].

Table 1: Weed population in upland rice as influenced by different weed control measures

| Treatment                      | Weed Intensity (m<sup>2</sup>) |
|--------------------------------|-------------------------------|
|                                | 20 DAS | 40 DAS | 60 DAS | 80 DAS | 100 DAS |
| T1 Weedy check                 |        |        |        |        |        |
| T2 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + Hand weeding at 40 DAS | 53.50 | 105.20 | 77.63 | 77.63 | 35.27 |
| T3 Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + Hand weeding at 40 DAS | 47.70 | 75.20 | 86.80 | 94.27 | 165.07 |
| T4 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4-D (Sodium salt) @ 1.0 Kg a.i. per ha at 30 DAS | 49.89 | 71.37 | 83.00 | 86.29 | 91.43 |
| T5 Hand weeding at 20 DAS + 2, 4-D (Sodium salt) @ 1.0 Kg a.i. per ha at 30 DAS | 50.40 | 61.22 | 79.93 | 109.33 | 107.38 |
| T6 Hoeing at 20 DAS + hand weeding at 30 DAS | 49.50 | 53.13 | 80.63 | 98.42 | 103.32 |
| T7 Hand Weeding at 20 DAS + Hoeing at 40 DAS | 49.06 | 73.38 | 82.00 | 100.22 | 104.35 |
| T8 Two hand weedings at 20 DAS & 40 DAS respectively | 49.80 | 69.31 | 75.00 | 86.24 | 91.39 |
| T9 Weed Free check 3 weedings at 20,40 and 60 DAS | 49.26 | 59.23 | 83.30 | 73.24 | 65.25 |
| “F” test                      | Sig.   | Sig.   | Sig.   | Sig.   | Sig.   |
| S.E ±                         | 1.29   | 0.63   | 2.00   | 2.26   | 2.89   |
| CD at 5%                      | 3.35   | 3.90   | 5.20   | 6.82   | 7.66   |
| G.M.                          | 50.20  | 70.09  | 80.93  | 94.82  | 98.72  |

Table 2: Weed dry matter as influenced periodically by different weed control measures

| Treatment                      | Total weed dry matter net/plot (g) | weed dry matter (q/ha) |
|--------------------------------|-----------------------------------|-----------------------|
|                                | 20 DAS   | 30 DAS   | 40 DAS   | 60 DAS   | At harvest | 60 DAS   | At harvest | 60 DAS   |
| T1 Weedy check                 | -        | -        | -        | -        | -          | -        | -          | -        |
| T2 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + Hand weeding at 40 DAS | -        | -        | 129.85   | -        | -          | 293.56   | -          | 2.690    |
| T3 Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence+ Hand weeding at 40 DAS | -        | -        | 105.32   | -        | -          | 257.96   | -          | 2.233    |
| T4 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4-D (Sodium salt) @ 1.0Kg a.i. per ha at 30 DAS | -        | -        | -        | -        | -          | 375.94   | -          | 3.717    |
| T5 Hand weeding at 20 DAS + 2, 4-D (Sodium salt) @ 1.0Kg a.i. per ha at 30 DAS | 66.60    | -        | -        | -        | -          | 370.84   | -          | 3.820    |
| T6 Hoeing at 20 DAS + hand weeding at 30 DAS | 64.06    | 76.63    | -        | -        | -          | 315.01   | -          | 3.013    |
| T7 Hand Weeding at 20 DAS + Hoeing at 40 DAS | 65.40    | -        | 88.58    | -        | -          | 372.53   | -          | 3.777    |
| T8 Two hand weedings at 20 DAS & 40 DAS respectively | 64.26    | -        | 68.41    | -        | -          | 212.47   | -          | 2.623    |
| T9 Weed Free check 3 weedings at 20, 40 and 60 DAS | 64.24    | -        | 56.49    | 41.65    | 181.94    | 161.94   | -          | 1.650    |
| “F” test                      | -        | -        | -        | -        | -          | -        | -          | -        |
| S.E ±                         | -        | -        | -        | -        | -          | -        | -          | -        |
| CD at 5%                      | -        | -        | -        | -        | -          | -        | -          | -        |
| G.M.                          | -        | -        | -        | -        | -          | -        | -          | -        |
Table 3: Nutrient (NPK) content (%) in grains and straw of upland rice Effect of weed control measures

| Treatment | Nitrogen (%) | Phosphorous (%) | Potassium (%) |
|-----------|--------------|-----------------|---------------|
|           | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| T1 Weedy check | 1.67 | 0.36 | 0.21 | 0.16 | 0.15 | 1.03 |
| T2 Pendimethalin @ 1.0 Kg a.i. per ha as pre emergence + Hand weeding at 40 DAS | 1.96 | 0.76 | 0.50 | 0.13 | 0.11 | 1.40 |
| T3 Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre emergence + Hand weeding at 40 DAS | 1.90 | 0.65 | 0.46 | 0.14 | 0.13 | 1.30 |
| T4 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4-D (Sodium salt) @ 1.0 kg a.i. per ha at 30 DAS | 1.81 | 0.50 | 0.25 | 0.12 | 0.12 | 1.22 |
| T5 Hand weeding at 20 DAS + 2,4-D (Sodium salt) @ 1.0Kg a.i. per ha at 30 DAS | 1.85 | 0.44 | 0.35 | 0.14 | 0.11 | 1.30 |
| T6 Hoeing at 20 DAS + hand weeding at 30 DAS | 1.82 | 0.40 | 0.20 | 0.15 | 0.10 | 1.16 |
| T7 Hand Weeding at 20 DAS + Hoeing at 40 DAS | 1.85 | 0.41 | 0.36 | 0.12 | 0.14 | 1.20 |
| T8 Two hand weedings at 20 DAS & 40 DAS respectively | 1.80 | 0.41 | 0.25 | 0.14 | 0.13 | 1.12 |
| T9 Weed Free check (3 weedings at 20, 40 and 60 DAS) | 1.80 | 0.41 | 0.28 | 0.16 | 0.16 | 1.23 |

Table 4: Nutrient content and uptake of nutrient (NPK) in weed at harvest as affected by different weed control treatment

| Treatment | Nitrogen (%) | Phosphorous (%) | Potassium (%) |
|-----------|--------------|-----------------|---------------|
|           | Uptake Kg per ha | Uptake Kg per ha | Uptake Kg per ha |
| T1 Weedy check | 0.830 | 9.057 | 0.233 | 3.180 | 1.010 | 11.270 |
| T2 Pendimethalin @ 1.0 Kg a.i.per ha as pre emergence + Hand weeding at 40 DAS | 0.787 | 2.000 | 0.283 | 0.753 | 0.960 | 2.690 |
| T3 Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + Hand weeding at 40 DAS | 0.817 | 2.167 | 0.243 | 0.660 | 0.980 | 2.530 |
| T4 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence+ 2,4-D (Sodium salt) @ 1.0 kg a.i. ha⁻¹ at 30 DAS | 0.813 | 3.220 | 0.273 | 1.010 | 1.020 | 3.663 |
| T5 Hand weeding at 20 DAS + 2, 4-D(Sodium salt) @1.0Kg a.i. per ha at 30 DAS | 0.820 | 3.033 | 0.253 | 1.030 | 0.990 | 3.660 |
| T6 Hoeing at 20 DAS + hand weeding at 30 DAS | 0.813 | 2.690 | 0.270 | 0.850 | 0.980 | 3.170 |
| T7 Hand Weeding at 20 DAS + Hoeing at 40 DAS | 0.797 | 3.013 | 0.273 | 1.073 | 1.040 | 3.690 |
| T8 Two hand weedings at 20 DAS & 40 DAS respectively | 0.790 | 1.410 | 0.290 | 0.537 | 0.900 | 2.160 |
| T9 Weed Free check (3 weedicings at 20,40 and 60 DAS) | 1.020 | 1.620 | 0.283 | 0.407 | 0.930 | 1.687 |

Table 5: Grain yield and straw yield of upland rice as influenced by different weed control measures

| Treatment | Grain Yield (q/ha) | Straw Yield (q/ha) |
|-----------|-------------------|--------------------|
| T1 Weedy check | 28.93 | 41.02 |
| T2 Pendimethalin @ 1.0 kg a.i. per ha as pre emergence + Hand weeding at 40 DAS | 44.00 | 100.27 |
| T3 Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre emergence + Hand weeding at 40 DAS | 47.10 | 101.39 |
| T4 Pendimethalin @ 1.0 Kg a.i. ha⁻¹ as pre emergence + 2,4-D (Sodium salt) @ 1.0 kg a.i. Per ha at 30 DAS | 40.07 | 81.22 |
| T5 Hand weeding at 20 DAS + 2, 4-D(Sodium salt) @1.0Kg a.i. per ha at 30 DAS | 44.70 | 73.33 |
| T6 Hoeing at 20 DAS + hand weeding at 30 DAS | 36.90 | 84.33 |
| T7 Hand Weeding at 20 DAS + Hoeing at 40 DAS | 36.05 | 77.33 |
| T8 Two hand weedings at 20 DAS & 40 DAS respectively | 44.60 | 104.38 |
| T9 Weed Free check (3 weedicings at 20, 40 and 60 DAS) | 50.02 | 109.45 |

Table 6: Economic of upland rice as influenced by different weed control measures

| Treatments | Gross returns (Rs./ha) | Cost of cultivation (Rs./ha) | Net returns (Rs./ha) | Benefit: Cost ratio |
|------------|-------------------------|-----------------------------|---------------------|-------------------|
| T1 Weedy check | 36602 | 41856 | -5254 | 0.87 |
| T2 Pendimethalin @ 1.0 kg a.i. per ha as pre-emergence +Hand weeding at 40 DAS | 111289 | 50452.5 | 60836.5 | 2.20 |
| T3 Butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + Hand weeding at 40 DAS | 117367 | 48998 | 68369 | 2.39 |
| T4 Pendimethalin @ 1.0 Kg a.i. per ha as pre-emergence + 2,4- D (Sodium salt) @ 1.0 kg a.i. per ha at 30 DAS | 86243 | 45792.5 | 40406.5 | 1.88 |
| T5 Hand weeding at 20 DAS + 2,4-D(Sodium salt) @1.0Kg a.i. per ha at 30 DAS | 94422 | 48622 | 45800 | 1.94 |
| T6 Hoeing at 20 DAS + hand weeding at 30 DAS | 100728 | 49921 | 50807 | 2.01 |
| T7 Hand Weeding at 20 DAS + Hoeing at 40 DAS | 90115 | 49915 | 40200 | 1.80 |
| T8 Two hand Weedings at 20 DAS & 40 DAS respectively | 120778 | 53308 | 67470 | 85.89 |
Conclusion
Rice is major crop of Uttarakhand and about 40-50 per cent of rice crop is grown under direct seeded condition. In direct seeded rice, weeds play the vital role in reducing the crop yield and there by resulting in high economic losses of farmers. Rice maximum growth and yield was obtained when the crop was kept weed free for the first 60 days by three hand weedicings. (20, 40 and 60 DAS). The highest crop growth, grain yield, weed control efficiency and weed dry matter in Under integrated weed management, treatment in recorded was practices butachlor 50% EC @ 1.25 Kg a.i. per ha as pre-emergence + hand-weeding at 40 DAS when compared with other integrated weed management practices. It is therefore imperative to manage weeds from early crop growth period so that the crop can make efficient utilization of applied and native input.

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