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INTEGRATING AGRICULTURAL AND CHEMICAL METHODS FOR EFFICIENT WEED CONTROL AND HIGH YIELDING IN DRILL-SEEDED RICE

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ABSTRACT

A field study was conducted during 2010 and 2011 rice growing seasons at Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt to detect the influence of integrating rice seeding-bed techniques and weed control on weeds and rice yields of drill-seeded rice.

The application of stale-bed technique including spraying glyphosate before drilling rice seeds significantly reduced weed dry weight while increased number of tillers, number of panicles /unit area and rice grain yield. All tested herbicide treatments (thiobencarb followed by penoxulam, thiobencarb alone at a high rate, penoxulame at a high rate and bispyribac alone) greatly suppressed dry weight of weeds in drill-seeded rice while significantly increased number of tillers, panicles/m^2 and rice grain yield/ha. Thiobencarb followed by penoxulam achieved the best weed control and the highest yield followed by penoxulam alone All weed control treatments were significantly efficient against weeds under the stale-bed technique even with the untreated check plots. Using thiobencarb followed by penoxulam achieved the highest efficiency against weeds and the highest number of tillers, panicles/m^2 and grain yield of drill seeded rice under both stale-bed and conventional techniques.

INTRODUCTION

Weeds reduce rice yields by competing with rice for light, water, and nutrients that would otherwise be fully available to the crop. The competitive advantage of weeds over rice is attributed to some weeds being C4 plants with high photosynthetic rates and corresponding high growth rates (unlike rice, which is a C3 plant); high potential to acclimatize to a changing environment; and more efficient seed production (Kim and Moody 1989).

Rice yield losses due to weed competition vary, depending on method of planting. The losses range from14-93% in direct-seeded rice and 17-47% in transplanted rice (Ranjit, 1997), and range from 40-80% in direct- sown rain field upland rice (Thakur and Bassi, 1994).

Direct seeding is a good alternative of transplanting and yield potential of direct- seeded rice is equivalent to the transplanted rice under good water management and weed control conditions (Awan *et al* 1989). Weeds pose a serious threat to the direct seeded rice crop by competing for nutrients, space and moisture throughout the growing season (Hussain *et al*, 2008). Ramzan (2003) reported yield reduction of 48, 53 and 74% in transplanted, direct seeded in flooded conditions and direct seeded in dry soils, respectively.

Direct seeding rice avoids the puddling and maintains continuous moist soil conditions and thus reduces the overall water demand for rice culture. The productivity of direct seeded rice is often reported to be lower, mainly due to problems associated with weed management. Growing rice under

aerobic environment can reduce water losses to a greater extent. Direct-seeding should be adopted instead of conventional transplanting to reduce the water and labor demand, which will ultimately reduce the cost of production (Mann *et al,* 2007).

Weed infestation continues to be a serious problem in dry seeded rice. Aerobic soil conditions and dry tillage practices, besides alternate wetting and drying conditions, are conductive for germination and growth of highly competitive weeds, which cause grain yield losses of 50-91 % (Elliot *et al* 1984, Fujisaka *et al* (1993). Therefore, an effective and economical weed control strategy needs to be implemented to overcome such serious weed competition and achieve high and stable yield in dry seeded rice (Hussain *et al* 2008). Singh *et al* (2005) reported good success with dry-seeded rice production technology in large-scale farmer participatory trials in India, when the stale-seed bed technique was combined with the application of pre-emergence herbicides. Thus, timely weed control is crucial to increasing rice productivity.

Success with stale-seeded bed technique depends on the patterns of weed emergence and, very importantly upon being able to keep the seed-bed moist and to allow sufficient time for most weeds to emerge prior to glyphosate application. These techniques were successful in suppressing the earlier emerging weeds, particularly *Echinochloa* spp. and smallflower umbrellsedge in dry water-seeded rice, respectively (Fischer *et al* 2007).

Several pre-emergence herbicides including thiobencarb, pendimethalin and oxadiazon alone or supplemented with hand weeding have been reported to provide a fair degree of weed control. In Egypt, applying drill-seeded rice method is increasingly needed due to shortage in labor and water. However, *Echincloa colona* (L) is one of dangerous weeds in drill- seeded rice, as it usually emerges faster than rice plants. (Hassan *et al.* 2001). While thiobencarb, bispyribac and penoxulam are recommended and available for weed control in broadcast-seeded rice.

The present study aims to implement seeding techniques and chemical application for efficient weed control and high yielding in drill-seeded rice.

MATERIALS AND METHODS

Two field experiments were conducted in 2010 and 2011 seasons at Rice Research and training center, Sakha, Kafer El-sheikh to study the effects of different herbicidal treatments (after planting) under stail-bed and conventional rice seeding techniques in both seasons. The experimental field was ploughed and dry leveled as recommended in drill-seeded rice for both experiments. For stale-bed technique, the field was irrigated and sprayed with glyphosate 48 % (at 2.4 L/ha) after the full emergence of weeds (10 days). In both experiments, Sakha 105 cultivar was drilled at 100 Kg/ha. Weed control treatments were: check (untreated), thiobencarb 50% followed by (fb) penoxulam, thiobencarb alone, penoxulam alone and bisyribac. In the second treatment, thiobencarb 50% was applied 3 days after planting (DAP) at 5L/ha followed by penoxulam 2.5% at 750 ml/ha 25 DAP. With the third treatment,

thiobencarb was applied 3 DAP at 7L/ ha as spraying method. Penoxulame and bispyribac were sprayed 25 DAP at 750 ml/ha and 2 L/ha, respectively. All herbicide treatments were sprayed in 400 liter of water per hectare on drained plots. The water was introduced the day after herbicide application and kept for 5 days. All other agronomic, water management and fertilization were applied as recommended for drill-seeded rice. A combined analysis was used between the two planting methods in each season.

Sampling and data were recorded as follows:

At 80 DAP, weeds in 50x50 cm quadrate replicated two times for each plot were pulled out, classified, dried for 24 hour at 70 c^o in an oven and dry weighed for total weeds was recorded.

For the rice plant, tiller number/m^2 was accounted and recorded at 80 DAP while number of panicles /m^2 was recorded at maturity. At harvest, the central 6 m^2 of rice were manually harvested, threshed and weighed. The yield as t/ha at 14% moisture was recorded. All recorded data were statistically analyzed and DMRT was used at 5% level of significancy for comparing average of treatments.

Statistical analysis:-

The analysis of variance was carried out as a combined analysis for the two planting methods in each season according to Gomez and Gomez (1984). Treatment means were compared by Duncan's Multiple Range Test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "MSTATC" computer software package.

RESULTS AND DISCUSSION

The effects of drill-seeded rice growing techniques, weed control treatments and their interaction on weeds and rice yield are presented in Tables (1-8).

A: weeds:

The recorded weed species in the untreated plots were*: Echonocloa colona* 40%, *E. crus-galli* 20%, *Dinebra retoflexa* 20, *xanthimum* sp 10% *Eclipta* sp 5% and *cyperus* sp 5% at 2010 season while the same species recorded 45, 15,25,5 and 5%, respectively in 2011 season.

Weed control treatments and their interactions in 2010 and seasons are presented in Tables (1) and (2).The application of the stale-bed technique (SBT) significantly reduced dry weight of total weeds than the conventional technique (Con.T.) in both seasons of the study. The reduction of weed presence under SBT treatment may be due to the eradication of the early flush of the emerged weeds before rice planting under this technique as mentioned by Fischer *et al* 2007.

Table (1): Weed dry weight (g/m^2) as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2010 season.

Treatment	Stale-bed technique	Con. T.*	Mean
Check	531.2 b	1203.8 a	867.5 A
Thiobencarb 50% fb. Penoxulam	31.1 h	52.4 h	41.8 E
Thiobencarb 50%	147.4 f	332.9 c	240.2 B
Penoxulam	104.3 g	193.2 e	148.8 D
Bispyribac	131.5 fg	245.7 d	188.6 C
Mean	189.1 *B*	405.4 *A*	

*** Con. T= Conventional techniques.**

*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

Concerning weed control treatments, all applied herbicides reduced dry weights of total weeds significantly lower as compared to weedy check plots. Thiobencarb followed by penoxulam treatment showed the highest weed suppression followed by penoxulam alone and bispyribec while thiobencarb alone ranked the least in weed suppression. The same trend was obtained during both seasons. The high efficiency of thiobencarb fb penoxulam treatment in weed control may refer to the early weed suppression by the pre-emergence treatment.

Table (2): Weed dry weight (g/m^2) as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2011 season.

Treatments	Stale-bed technique	Con. T.*	Mean
Check	611.3 b	1310.2 a	960.8 A
Thiobencarb 50% fb. Penoxulam	40.3 h	66.7 h	53.5 E
Thiobencarb 50%	151.2 f	353.8 c	252.5 B
Penoxulam	106.8 g	198.8 e	152.8 D
Bispyribac	155.7 f	263.4 d	209.6 C
Mean	213.1 *B*	438.6 *A*	

*** Con. T= Conventional techniques.**

*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

For the interaction between seeding techniques and weed control treatments, data in tables (1) and (2) showed that except thiobencarb fb bispribac under SBT, dry weight of weeds showed significant reduction under other weed control treatments even with weedy check plots. The lowest dry weigh of weeds was recorded by thiobencarb fb penoxulam treatment followed by penoxulam or bispyribac alone under SBT while the untreated check plot recorded the heaviest dry weight of weeds. The same trends were observed in both seasons of the study.

The non significant differences between dry weight of weeds under both seeding techniques with thiobencarb fb. penoxulom may explain the overcoming of the excessive weed flushes by the sequence of application for early and late applied herbicides as reported by Mann *et al* , (2007).

B- Rice Crop

1- Number of tillers /m^2

Data shown in Tables (3) and (4) express the mean values of tiller number /m^2 as affected by rice seeding techniques , weed control treatments and their interaction during 2010 and 2011 **season. It** is evident that growing drill-seeded rice under the stale-bed technique produced higher tillers than under conventional one. The increased number of tillers / m^2 for rice under SBT application may be refered to the early eradication of weeds which in turn enabled rice plants to receive more nutrients, light and other needed resources, hence, increasing tillering ability for rice plants.

Table (3): Number of rice tillers/m^2 as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2010 season.

Treatments	Stale-bed technique	Con. T.*	Mean
Check	64.0 e	29.4 f	46.7 D
Thiobencarb 50% fb. Penoxulam	685.0 a	641.5 b	663.3 A
Thiobencarb 50%	558.0 c	455.3 d	506.7 C
Penoxulam	653.0 ab	583.4 c	618.2 B
Bispyribac	582.5 c	443.6 d	513.1 C
Mean	508.5 *A*	430.6 *B*	

*** Con. T= Conventional techniques.**

*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT..**

In respect to weed control treatments, number of tiller /m^2 of rice was positively affected by all herbicide treatment as compared to the untreated check plots. Thiobencarb fb penoxulam treated plots recorded the greatest number of tillers per unit area followed by penoxulam alone while the use of thiobencarb alone or bispyribac alone showed lower number of tillers /m^2 for rice plants. The superiority of thiobencarb followed by penoxulam in increasing number of tillers / m^2 for rice plants may be due to the early weed suppression by the first treatment and the late weed control by the second one of post herbicide application which effectively exclude weed competition as mentioned by Singh *et al* 2005.

Concerning the interaction between rice cultivation techniques and weed control treatments, it is clear from data in Tables (2) and (4) that number of tillers per unit area was greatly affected by this interaction during the two seasons. Under stale-bed technique, with the application of thiobencarb followed by penoxulam or with penoxulam alone at the high rate, tillers /m^2 recorded the highest figures followed by the application of thiobencarb followed by penoxulam under conventional technique for drill-seeded rice cultivation. On the other side, the untreated check plots under the conventional technique produced the lowest number of tillers followed by the same treatment under the stale-bed technique. The inferiority of number of tillers of rice per unit area under this condition may explain the adverse effect of severe weed competition especially under the conventional seeding technique for rice as mentioned by Fujisaka *et al* (1993).

Table (4): Number of rice tillers/m^2 as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2011 season.

Treatment	Stale-bed technique	Con. T.*	Mean
Check	56..4 f	23.8 g	40.1 D
Thiobencarb 50% fb. Penoxulam	673.3 a	636.3 b	654.8 A
Thiobencarb 50%	543.2 d	450.1 e	496.7 C
Penoxulam	648.4 b	571.8 c	610.1 B
Bispyribac	573.6 c	434.4 e	504.0 C
Mean	498.9 *A*	423.3 *B*	

*** Con. T= Conventional techniques.**
*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

2- Number of panicles /m^2:

Data on number of panicles per unit area as influenced by drill-seeded rice, planting techniques, weed control treatments and their interaction are presented in Tables (5 and 6). It is obvious that panicles/m^2 were significantly affected by seed-bed techniques. Rice plots grown under the stale-bed technique produced more panicles than those grown und the conventional technique. The same trend was observed during 2010 and 2011 seasons. The high number of panicles per unit area of drill- seeded rice under SBT may refere to the eradication of the first flushes of germinated weeds before rice drilling and the strong rice growth under this condition. These results are in agreement to those reported by Fischer *et al* (2007).

Regarding to weed control treatments, it is obviously clear from the data in Tables (5 and 6) that number of panicles/m^2 was significantly affected by the application of weed control treatments.

Table (5): Number of rice panicles/m^2 as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2010 season.

Treatments	Stale-bed technique	Con. T.*	Mean
Check	93.3 g	22.5 h	57.9 D
Thiobencarb 50% fb. Penoxulam	629.5 a	600.8 a	615.2 A
Thiobencarb 50%	491.3 d	371.5 f	431.4 C
Penoxulam	575.8 b	487.0d	531.4 B
Bispyribac	533.5 c	428.8 e	481.2 C
Mean	464.6 *A*	382.1 *B*	

*** Con. T= Conventional techniques.**
*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

All the applied herbicide treatments greatly increased number of panicles/m^2 as compared to the untreated check plots. The application of thiobencarb followed by penoxulam resulted in the largest number of panicles per unit area followed by the treatment of penoxulam alone at the higher rate while thiobencarb alone produced the least figures of panicle densities. The same trend was true during the two seasons.

Table (6): Number of rice panicles/m^2 as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2011 season.

Treatments	Stale-bed technique	Con. T.*	Mean
Check	82.8 g	21.3 h	52.05 E
Thiobencarb 50% fb. Penoxulam	618.6 a	596.4 a	607.50 A
Thiobencarb 50%	488.2 d	368.6 f	428.40 D
Penoxulam	568.4 b	478.3 d	523.35 B
Bispyribac	522.3 c	419.7 e	471.00 C
Mean	456.01 *A*	376.86 *B*	

*** Con. T= Conventional techniques.**

*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

In respect of the interaction between stale-bed techniques and weed control treatments, it is clear that number of rice panicles per unit area was significantly influenced by this interaction. The highest number of panicles /m^2 was recorded with the application of thiobencaeb followed by penoxulam under both techniques of drill rice seeding. The obtained number of rice panicles per unit area under the application of penoxulam alone or bispyribac ranks second with the stale-bed technique. On the other hand, all weed control treatments even the untreated plots produced panicles of rice per unit area significantly more under the stale-bed technique except for thiobencarb followed by penoxulam treated plots. The superiority of thiobencarb followed by penoxulam treatments under both stale-bed and conventional rice seeding techniques may refere to the appropriate time of weed control which in turn increased rice panicles per unit area as mentioned by Singh *et al* (2005).

3- Rice grain yield (t. / ha.)

Data on grain yield of drill-seeded rice (t./ha.) as influenced by seeding –bed techniques, weed control treatments and their interaction for 2010 and 2011 seasons are presented in Tables (7 and 8). Concerning seed-bed techniques, drill-seed rice plots under the stale-bed technique yielded rice grains considerably higher than those grown under the conventional one during 2010 and 2011 seasons. The low grain yield of drill-seeded rice under conventional technique may be related to the aerobic soil conditions and dry tillage practices, besides the alternative moisture conditions which resulted in severe weed infestation and competition as reported by Elliot *et al* (1984) and Fujisaka *et al* (1993).

Table (7): Rice grain yield (t./ ha.) as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2010 season.

Treatments	Stale-bed technique	Con. T.*	Mean
Check	1.64 e	0.456 f	1.048 D
Thiobencarb 50% fb. Penoxulam	10.10 a	10.08 a	10.090 A
Thiobencarb 50%	9.18 bc	8.59 d	8.885 C
Penoxulam	9.92 a	8.92 cd	9.420 B
Bispyribac	9.32 b	8.69 d	9.005 C
Mean	8.03 *A*	7.35 *B*	

*** Con. T= Conventional techniques.**

*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

As shown in Tables (7 and 8), grain yield of drill-seeded rice was significantly influenced by weed control treatments. All the applied herbicide treatments showed great increases in rice grain yield as compared to the untreated check plots during both seasons of the study. The application of thiobencarb followed by penoxulame resulted in the highest grain yield of rice followed by the use of penoxulam alone at the high dose and the application of bispyribac or thiobencarb alone. The same trend was true during 2010 and 2011 seasons. The superiority of using thiobencarb as an early application followed by a late one may resulted in the effective weed suppression during the critical period of competition as mentioned by Radosevich *et al* (1997).

Table (8): Rice grain yield (t./ ha.) as influenced by seeding techniques, weed control treatments and their interaction in drill-seeded rice during 2011 season.

Treatments	Stale-bed technique	Con. T.*	Mean
Check	1.73 f	0.57 g	1.147 D
Thiobencarb 50% fb. Penoxulam	10.06 a	10.03 a	10.05 A
Thiobencarb 50%	9.13 c	8.61 de	8.87 C
Penoxulam	9.81 a	8.88 cd	9.35 B
Bispyribac	9.43 b	8.54 e	8.99 C
Mean	8.03 *A*	7.33 *B*	

*** Con. T= Conventional techniques.**

*** Means followed by a common letter with the same symbol are not significantly different at the 5%level by DMRT.**

In respect to the interaction between seed-bed techniques and weed control treatments, grain yield of drill-seeded rice was significantly affected by this interaction during both seasons of study (Tables 7 and 8).

The application of thiobencarb followed by penoxulam produced the highest grain yield of drill-seeded rice under both seeding techniques. On the other hand, all other weed control treatments under the stale-bed technique resulted in grain yields significantly higher than those under the conventional seeding, even in the untreated plots. Additionally, the use of penuxulam alone at the high dose produced grain yield significantly equal to the use of thiobencarb followed by penoxulam at the low dose under SBT in 2010 season. The high yielding potentiality of drill-seeded rice with the application of thiobencarb followed by penoxulam under both seeding techniques may be attributed to the obtained vigorous growth and large number of panicles per unit area as major yield component resulting from the effective weed control achieved under this treatment which allowed rice plants to grow free of weed competition as reported by Hussain *et al* 2008. Moreover, the superior productivity of drill–seeded rice under stale-bed technique may explain the success of such technique to suppress the earlier emerged weeds especially grassy ones which are the most troublesome for rice yield losses as reported by Fischer *et al* (2007).

Conclusion:

Based on the obtained results, it could be concluded that drill-seeded rice area could be extended through the application of stale-bed technique and the effective weed control to overcome the serious weed problems in drill-seeded rice.

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التكامل بين الطرق الزراعية والكيماوية لأجل مكافحة فعالة للحشائش وإنتاجية مرتفعة في الأرز التسطير.

إبراهيم حمدى أبوالدرج

قسم بحوث الأرز، معهد بحوث المحاصيل الحقلية ، مركز البحوث الزراعية

أقيمت تجربتان حقليتان خلال موسمي 2010، 2011 في بمركز البحوث والتدريب في الأرز - سخا، - كفر الشيخ، لدراسة التكامل بين نظم إعداد مهد البذرة والطرق الكيماوية لأجل مكافحة فعالة للحشائش وإنتاجية مرتفعة في الأرز التسطير.

وأوضحت النتائج أن طريقة المهد المروى مسبقا والمعامل بمبيد الجليفوسيت قبل الزراعة أظهرت تفوقا معنويا في النتائج حيث كان هناك نقص واضح في الوزن الجاف للحشائش وعلي الجانب الأخر زيادة في عدد الفروع وعدد السنابل فى الأرز في وحدة المساحة وكذلك زيادة واضحة في محصول الحبوب.

وقد سجلت كل معاملات المبيدات داخل الدراسة (ثيوبنكارب يليها بنكسولام، وثيوبنكارب منفردا) نقصا واضحا في الوزن الجاف للحشائش وزيادة معنوية في عدد الفروع وعدد السنابل في وحدة المساحة وكذلك في المحصول الناتج من الحبوب.

وقد سجلت معاملة الثيوبنكارب المتبوع بالبنكسولام فى نفس القطعة أحسن المعاملات في مكافحة الحشائش وزيادة في المحصول يليها معاملة البنكسولام منفردا

وكانت جميع معاملات المبيدات مع المعاملة بالجليفوسيت فى المهد المروى قبل الزراعة أفضل في مكافحة الحشائش وزيادة المحصول مقارنة بنفس المعاملات مع طريقة الزراعة بدون رى أو المعاملة بالجليفوسيت قبل الزراعة (الطريقة التقليدية).

لذا توصى الدراسة بمعاملة الجليفوسيت لمهد البذرة المروى مسبقا قبل الزراعة لتقليل عدد الحشائش خاصة فى ظروف الزراعة الجافة.

قام بتحكيم البحث

أ.د / احمد نادر السيد عطيه — **كلية الزراعة – جامعة المنصورة**

أ.د / سعد محمد شبل — **مركز البحوث الزراعية**