DISSERTATION REPORT- II

"Weed control methods on weed dynamics and weed management in maize (*Zea mays L.*)"

Submitted To:

Lovely Professional University,

Phagwara (Punjab)

Submitted by**:**

Rajeev Sharma

M.Sc. Agronomy

Reg. No. - 11617562

DEPARTMENT OF HORTICULTURE
SCHOOL OF AGRICULTURE
LOVELY PROFESSIONAL UNIVERSITY PUNJAB 144411

CERTIFICATE

Certified that this synopsis of Rajeev Sharma, registration no. 11617562, entitled **"weed control methods on weed dynamics and weed management in maize *(Zea mays* L.)"** has been formulated and finalized by the student himself on the subject.

(Signature of Student)
Rajeev Sharama
11617562
School of Agriculture,
Lovely Professional University,
Phagwara, Punjab.

(Signature of Supervisor)
Dr. Anupama Singh
UID-20782
School of Agriculture,
Lovely Professional University,
Phagwara, Punjab.

(Signature of Co- advisor)
Dr. Arun Kumar
UID-19105
School of Agriculture,
Lovely Professional University,
Phagwara, Punjab.

INTRODUCTION

Maize is largely cultivated crop in north India. Major maize growing stats are: UP, Rajasthan, Madhya Pradesh, Bihar, Himachal Pradesh, Jammu and Kashmir and Punjab which together account for two-third of the total area and output of the crop. Karnataka and Andhra parades' states are the major production of maize in south India. MP rank first in the production of maize in the country.

Maize is one of the most important Kharif crop grown in India and occupies an area of 8.7 million hectares with annual production of 22.3million tons (Anonymous, 2012). The maize production in Punjab is 2012-13 was 4.71 lakh metric tons, and the total area under the crop was 1.29 lakh hectares (Department of Food Processing Punjab 2013). With an average productivity of 3,650 kg/ha, farmers cultivating maize made substantial profits that year. The strategy of the Department of Agriculture, Punjab (DoAP) for the Twelfth Five-Year Plan period (2012-2017) has been to shift the area under paddy cultivation to alternative crops like cotton, maize, pulses, fodder, sugarcane, fruits and vegetables, and agro-forestry to contain damage to the natural resource base. To encourage the cultivation of these alternative crops, the department proposed a few initiatives such as a remunerative minimum support price (MSP), subsidy on seeds to cover production risks and to incentivize the farmers to shift to other crops and the creation of an efficient marketing infrastructure and mechanism for crops other than paddy. Maize is grown throughout the year in all states of the country for various purposes including fodder for animals, food grain, sweet corn, baby corn, green cobs and popcorn. Corn flour is consumed in Indian in cooking.

Maize can be grown in all seasons via; *Kharif* (monsoon), post monsoon, *Rabi* (winter) and spring. During *Rabi* and spring seasons to achieve higher yield at farmer's field assured irrigation facilities are required. During *Kharif* season it is desirable to complete the sowing operation 12-15 days before the onset of monsoon. However, in rain fed areas, the sowing time should be coincided with onset of monsoon. In Kharif season the optimum time of sowing of maize is Last week of June to first fortnight July, in Rabi season Last week of October for inter cropping and up to 15th of November for sole crop and in spring season First week of February.

Weed management has been of primary importance to the farmers whose efforts for combating the weed menace in maize mostly involve hand weeding and hoeing operations. But these manual methods are laborious, time consuming and involve high costs of labor. Therefore the best alternative to mitigate the competition by weeds right from early stages is application of pre-emergence herbicides. At present, Atrazine a pre-emergence herbicide has been recommended to control weeds in this crop. But, because of narrow spectrum of weed control and chances of development of herbicide resistance with wide spread and continuous use of atrazine (Holt and LeBaron, 1990), there is urgent need to find out the alternative herbicide with different mechanism of action for effective control of weeds.

Control of weeds in the fields of maize is, therefore, every essential for obtaining good crop harvest. Weed control practices in maize resulted in 77 to 96.7% higher grain yield than the weedy check. Different weed control methods have been used to manage the weeds but mechanical and chemical methods are more frequently used for the control of weeds than any other control methods. Mechanical methods including hand weeding are still useful but are

getting expensive, laborious and time-consuming. In the less developed countries, the situations still exists where the peak labor requirement in often for hand weeding. Herbicides weed control is an important alternative to manual weeding because it is cheaper, faster and gives better control. Chemical control is a better alternative to manual weeding because it is cheaper, faster, and gives better control. Weed control in maize with herbicides has been suggested by researcher (Ali *et al.,* 2003)

Keeping all these aspects in mind, the present study entitled, "weed control methods on weed dynamics and weed management in maize *(Zea mays* L.)" Undertaken with the following Objectives:

OBJECTIVES

1. To study the integrated effect of hand weeding and chemical methods on dynamics of weed flora and its management
2. Efficiency of different herbicides.

REVIEW OF LITERATURE

(Tesfay *et al.,* 2014) were observed about the effect of different post and pre emergency herbicides application on weed dynamics in maize (*Zea mays* L.) variety, BH-660 in randomized complete block design with three replications. Six treatments including Nicosulfuron (Arrow 75 WDG) at 0.09 kgha-1+ silwet gold (adjuvant) at 0.10%, S-metolachlor 290 + Atrazine *(*Primagram) at 3.00 kgha-1, s-metolachlor (dual gold) 1.5 kgha-1, hand weeding as standard check and weedy check as control were used. Effect of different herbicides on weed density was significant. However, no significant difference was observed between Nicosulfuron and Primagram. The minimum dry weight of weeds (0.77 gm-2) was observed in hand weeding and hoeing followed by Nicosulfuron which is not significantly different from s-metolachlor. Moreover, those treatments also significantly increased the yield and yield component of maize. This is an indication of the reliability and promise as well as the exhibition of the great potential of the Nicosulfuron is the effective control of the weeds and enhancing yield of maize in Guder and Ambo, Ethiopia.

(N. Sampaio *et al.,* 2015) was to evaluate the weed management in maize using hoeing and intercropping with *Mimosa caesalpiniifolia* ('sabia'). A randomized block design that consisted of split plots and five replicates was used. The hybrids AG1051 and BR205 (plots) received the following treatments: A = hoeing [20 and 40 days after sowing the maize (DASM) and without intercropping]; B = hoeing 20 DASM followed by the planting of 'sabiá'; C = planting of 'sabiá' at the time the maize was sown followed by hoeing 40 DASM; D = planting of 'sabiá' at the time the maize was sown; and E = no hoeing and without intercropping. Lesser weed growth in the plots of two hybrids was observed with the treatments that involved hoeing. The highest yields for maize were obtained with two hoeing. The combinations of hoeing and intercropping provided higher grain yield compared to only intercropping with sabia. Grain yield with hoeing 20 DASM and intercropping with sabia was higher compared to intercropping with sabia and hoeing 40 DASM.

(Veeresh hatti. 2013)An experiment entitled "Evaluation of pre and post-emergence herbicides for weed management in irrigated maize (*Zea mays* L.)" was conducted Major weeds observed were *Cyperus rotundus*, *Cynodon dactylon, Ageratum conyzoides* and *Cleome monophylla*. Oxyflurofen- 200 g ha-1 + 2, 4-D Na-500 g ha-1 recorded significantly higher kernel yield, net returns and B:C ratio (6107 kg ha-1, Rs. 61,013 ha-1 and 3.35) followed by two hand weedings (6081 kg ha-1, Rs. 57,790 ha-1 and 3.00) and topramezone - 25.2 g ha-1 + atrazine – 250 g ha-1 (5864 kg ha-1, Rs. 58,887 ha-1 and 3.38) compared to atrazine -1000 g ha-1 (4638 kg ha-1, Rs. 41,981 ha-1 and 2.71) and weedy check (2157 kg ha-1, Rs. 8,238 ha-1 and 1.35) without any phytotoxicity on maize.

Channabasavamna *et al.,* 2015 experiment was laid out in randomized block design with three replications. There were 13 treatments involving two pre-emergence herbicides *viz.,* atrazine 50 WP (1250 g a.i. ha-1) or pendimethalin 30 EC (1500 g a.i. ha-1) applied alone or in combination as tank mix or sequence application with post-emergence herbicides *viz.,* 2, 4-D sodium salt 80

WP (2000 g a.i. ha-1) and metsulfuron methyl 20 WG (4 g a.i. ha-1). These were compared with hand weeding, farmers practice and weedy check. The data revealed that tank mix application of atrazine 50 WP @ 625 g a.i. ha-1 + pendimethalin 30 EC @ 750g a.i. ha-1 applied as preemergent gave excellent control of all types of weeds, higher weed control efficiency and lower weed index. This treatment also recorded higher grain yield (6.63 t ha-1), net returns (68093 ha-1) and benefit cost ratio (4.18). Application of metsulfuron methyl 20 EC @ 4.0 g a.i. ha-1, though controlled weeds very efficiently but phytotoxic to maize.

Larbi1 et al., 2013 Field studies were conducted at the University of Ghana, Legon farm from June to September 2005 to investigate the growth and yield of maize (*Zea mays*) in response to herbicide application. Four groups of herbicides; 2, 4-D (Bextra and Calliherbe), glyphosate (Kalach 360SL, Fire and Weed Out), Atrazine (Callitraz 500SC and Trazine 500SC) and Paraquat (Gramoxone Super and Benaxone) were used. Each of the named herbicides constituted a treatment, with hand weeding as the control. In all, there were ten treatments and four replicates arranged in a randomized complete block design. Paraquat and gyphosate treatments were applied before sowing; Atrazine and 2, 4-D was applied two days after sowing. The compound fertilizer 15-15-15 (N-P-K) at the rate of 250 kg/ha was applied as side dressing 2 WAP. Top dressing with sulphate of ammonia at rate of 125 kg/ha was applied 6 WAP. Analysis of variance (ANOVA) for the data was carried out using (Genstat 5 statistical package, 1997). Significant differences between means were estimated by the Least Significant Difference at 5% level of significance. Results revealed that dry matter accumulation, leaf area were similar in all treatments across the sample period. Glyphosate, Paraquat and Atrazine treatment had dry matter accumulation similar to the control. 2, 4-D treatment however had higher dry matter at 2 WAP. Although there was no difference in the number of kernels per plant among the various treatments 2, 4-D treatment plots produced 33 to 41% less as compared to the control in yield per hectare.

Abdullahi et al., 2016 A field experiments was carried out at Agronomy field SHIATS Allahabad, during Kharif season of 2015 to study the “Effect of different weed control methods on growth and yield of maize” (Zea mays L.). The experiment comprised eleven treatments, Viz ; weed free, 2 hand weeding, Paddy straw mulching, black polythene mulching, Atrazine @ 0.75

kg ha-1, Atrazine @ 1.00 kg ha-1, Atrazine @ 1.50 kg ha-1, Atrazine @ 0.75 kg ha-1 + hand weeding, Atrazine @ 1.00 kg ha-1 + hand weeding, Atrazine @ 1.50 kg ha-1 + hand weeding and un weeded plot. There are many weed species that were observed in the field experiment, but the major weed species were:- Cynodon dactylon, Cyperus rotundus, Parthenium hysterophorus L. and Chenopodium album L. .The result showed that, the most effective treatment among other treatment in controlling weed population and increasing the grain yield of maize were Atrazine @1.00 kg ha-1 + hand weeding, 2 hand weeding and Paddy straw mulching, producing grain yield of (203.48 g, 188.34 g and 186.82 g) respectively as compared with (68.30 g) from un weeded plot. Higher net return (Rs.91700) and benefit cost ratio (3.40 & 2.48) was registered in the treatment in T9 and T3 respectively. These weed control methods significantly controlled weed and enhanced yield and yield components of maize during the study. Therefore it were concluded that, 2 manual hand weeding and Atrazine @ 1.0 kg ha-1 + one hand weeding at 45 DAS, is more effective and economic as compared with other treatment

Hassan et al., 2010 A field experiments to study the impact of integrating cultivars with reduced herbicide rates for the weed management in maize (*Zea mays* L) was conducted at NWFP Agricultural University, Peshawar. Crop was sown during mid of June, 2007 in a randomized complete block (RCB) design with three replications with split plot arrangement. Two local maize cultivars (Azam and Pahari) were used as main plots. The three herbicides as full recommended doses (1x) and their half doses (½x) used as sub-plots viz; pendimethalin (Stomp 330E) @ 1.32 and 0.66 kg a.i. ha-1; s-metolachlor (Dual gold 960 EC) @ 1.44 and 0.72 kg a.i ha-1 and atrazine (Atrazine 38 SC) @ 1.57 and 0.78 kg a.i ha-1 and a weedy check. Each sub-plot measured 5.6 x 3 m2. Data were recorded on weed density (after 30 days of herbicides application), fresh weed biomass, plant height, leaf area, 1000- kernel weight, kernel yield and phytotoxicity of herbicides on crop if any. For the main effects of cultivars, all the parameters were non-significant. For herbicides, significant differences were recorded in all parameters, while the interaction also manifested non-significant differences for all the traits except 1000 kernel weight. Cultivar Azam alongwith s-metolachlor with full dose (1x) followed by half dose (½x) and their interaction offered the best weed management in maize. It is thus recommended that half of the recommended dose of s-metolachlor integrated with cv. Azam may be used to harvest economic yield of maize while keeping the environment intact.

Williams et al., 2014 Effective weed control in corn (Zea mays L.) is important to optimize yield. Concern over environmental impact of atrazine and selection for glyphosate resistance has increased the need to develop alternative strategies that use herbicides other than atrazine and glyphosate and appropriate cultural practices to control weeds. Research was conducted during 2011 and 2012 to determine weed and corn response to herbicide programs containing dicamba, glufosinate, and glyphosate applied postemergence alone or with atrazine in single- and twin-row planting patterns. Planting pattern had no effect on common ragweed (Ambrosia artemisiifolia L.) and Texas panicum (Panicum texanum L.) population and did not interact with herbicide program. Effective weed control hastened maturity in some but not all instances. Under weed-free conditions, corn grain yield was higher in 5 of 7 trials when planted in twin rows versus single rows at equivalent corn populations (141,000 plants ha−1). These results suggest that while planting pattern may not impact weed control dramatically, planting corn in twin rows may be an effective alternative to single-row planting patterns because of increased yield under high corn populations

Bogdan *et al.,* 2006 the results obtained under soil-climatic conditions of Cluj- Napoca, Romania, during 2003-2005. The main goal of experiments was to establish an optimal network for weed control in maize crops. High weed encroachment of maize crops in Cluj area has increased, due to weed seed stock in the arable layer and weather conditions, which allowed weeds to grow alternatively, and to the development of problem species during the maize vegetation period, when no tillage was performed. A good efficiency in controlling the entire weed spectrum from maize crops and with high persistence was the combination of an acetochlore-based herbicide. The variant RELAY 90EC 2.2 l/ha, applied at the stage of preemergence, florosulam based-herbicide and acid 2.4D: MUSTANG 0.6 l/ha, applied at the stage of post-emergence, had a control degree of 72%, for the entire vegetative period. The average control degree was achieved by variants controlled before emergence with DUAL GOLD 960 EC 1.5l/ha. In vegetation, the complex herbicides OLTISAN M. 1l/ha or RING 80 WG 25 g/ha were used, the average control degree being of 73%, respectively, 75%.

Nadeem *et al.,* .2008 field experiment was conducted to assess the growth and yielresponse of autumn planted maize and its weeds to application of a new post-emergence herbicide Equip (foramsulfuron + isoxadifen-ethyl) alone and in combination with urea. The experiment comprised weedy check, manual weed control, foramsulfuron + isoxadifen-ethyl @ 1125 g a.i. ha-1 alone, foramsulfuron + isoxadifen-ethyl @ 1125, 1012 and 900 g a.i. ha-1 with 3% urea solution. Result revealed that application of full dose of herbicide in combination with urea gives better result than the use of full dose of herbicide alone. Weeds density and total weed dry weight 20, 40 days after spraying (DAS) and at harvest decreased significantly when foramusulfuron + isoxadifen-ethyl along with urea as adjuvant at 1125 g a.i. ha-1 was applied compared to application of herbicide alone at 1125 g a.i. ha-1. Full dose of herbicide foramsulfuron + isoxadifen-ethyl at 1125 g a.i. ha-1 alone showed statistically similar results as reducing dose of herbicide foramsulfuron + isoxadifen-ethyl at 1012 g a.i. ha-1 + 3% urea in reducing weeds density, dry weight and increasing yield of maize. The study revealed that the herbicide dose can be reduced up to 10-12% if urea solution was used as adjuvant to obtain the same efficiency as with full dose without compromising on maize yield. Muhammad Tahir, M. Rashad Javed, Asif Tanveer, M. Ather Nadeem, Allah Wasaya

Bukhari and Rehman 2009 to study the effect of new pre-emergence herbicide Penthalin plus-35EC (Pendimethalin 20 % + prometryn 15 %) on weeds, growth and yield of spring planted maize (*Zea mays* L.). The experiment comprised eight treatments: weedy check, Penthalin plus-35EC @ 2000, 2500, 3000, 3500, and 4000 ml ha-1 (Pendimethalin + prometryn @ 700, 875, 1050, 1225 and 1400 g a.i ha-1), Stomp-35EC @ 3000 ml ha-1 (Pendimethalin @ 1050 g a.i ha-1) and manual hoeing. Main weeds were *Cyperus rotundus*, *Tribulus terrestris*, *Dactyloctenium aegyptium* and *Cyndon dactylon*. The results showed that the most effective treatment in controlling weed, reducing the dry matter of weed and increasing maize grain yield were manual hoeing, stomp 35-EC (Pendimethalin @ 1050 g a.i. ha-1) and Penthalin plus-35EC (Pendimethalin + Prometryn @ 1225 g a.i. ha-1), producing grain yield of 8.05, 7.92 and 7.671 t ha-1, respectively as compared to 4.561 t ha-1 for untreated control plot. The study concludes that manual hoeing and stomp 35-EC can be more effective as compare to all other treatments without compromising on maize grain yield loss due to weeds

MATERIAL AND METHODS

A field experiment on Effect of Pre and Post-emergence herbicides on weed control in maize will be conducted during *kharif 2017* on lovely professional university field, village Hardaspur of Kapurthala district under rain fed condition. The details of the experiment used and the experimental techniques followed during the course of investigation are presented in the chapter.

Experimental details:

The details of the experiment with regard to treatments, design adopted and plot size is Given below.

Treatments:

Description of the herbicides used in the experiment
Descriptions of the following herbicides were given by Mandal (1995).

T0: Control

T1 Pendimethlin @ 1500g/hectare Pre-emergence

T2: Atrazine 50% wp@ 1250g/hectare in pre-emergence

T3: Atrazine 50% wp@ 1250g/hectare in post-emergence

T4: Laudis + Atrazine @300ml+500g in post-emergence

T5: Zura (2,4D amino acid 58%) @ 1L IN Post-emergence

T6: Laudis 300ml in Post emergence

S.no	TREATMENTS	DOSE (g/ha)	TIME OF APPLICATION
1.	Control		
2.	Pendimethlin	1500g	Pre- emergence
3.	Atrazine 50%	1250g	Pre-emergence
4.	Atrazine 50%	1250g	Post-emergence
5.	Paraquat	2.5L	Post-emergence
6.	Laudis (tembotrione)34.4 w/WSE + half kg Atrazine	300ml+500g	Post-emergence
7.	Zura (2,4D Amino acid 58%)	1L	Post- emergence
8.	Sathi (phyrazol sulphrn 10%wp	200g	Post- emergence

Design and layout

The experiment was laid out in a randomized complete block design (RBD) with three Replications. The gross plot size was 6.0 m x 3.6 m with net plot of 5.6 m x 2.4

Replication 3	Replication 2	Replication 1
Control	T7	T3
T2	T6	T5
T3	T5	T2
T4	T4	T6
T5	T3	T7
T6	T2	Control
T7	Control	T4

A) Experimental details:

1. Year of experimentation : 2017
2. No. of treatments : 8
3. No. of replication : 3
4. Total no. of plots : 24
5. Plot size : 6.0m x 3.6m
6. Date of sowing : First week of June
7. Experimental design : Complete Randomized Block Design(RCBD)
8. Crop and variety : Maize and Kaveri-50
9. Plant to plant Distance : 20cm
10. Row to Row Distance : 60cm
11. Estimated area needed : 672 sq. m

Observations

(A) Growth and Development

- Emergence count
- Plant height
- Dry matter accumulation
- Days to 50% flowering
- Days of first flowering
- Days to maturity
- days of emergence
- lodging percentage

B) Grain Yield

- Days taken to flowering and senescence
- Number of pods per plant
- Cob length
- Number of seeds per cob
- Shelling percentage
- 100 seed weight/Test weight
- Cob yield (q/ha)
- Straw yield (q/ha)
- Harvest index
- Biological yield
- Depth of emergence of different weed species
- Species wise and total weed count
- Weed seed bank studies
- Species wise and total dry matter of weed.
- Protein content in maize grain
- Starch content in maize grain

C) Economics studies:

- Cost of cultivation/cost of weed Control (Rs/ha)
- Total Gross return/gross return due Weed control (Rs/ha)
- Net return/net returns due to weed Control (Rs/ha)
- B: C ratio/net return per rupee Invested on weed control

Statistical Analysis

The data obtained were subjected to statistical analysis as outlined by Gomez and Gomez (1984) and were tested at 5 per cent level of significance to interpret the treatment differences. The weed count data, weed dry matter data and weed seed bank data were analyzed after subjecting

the original data to x+1 transformation and the treatment effects were compared by using transformed means.

RESULT

- Best treatments : T3: Atrazine 50% wp@ 1250g/hectare in pre-emergence

  T4: Atrazine 50% wp@ 1250g/hectare in post-emergence
- Total yield :
- Best yield from plots :
- Best no of seeds per cob :
- Best cob length :
- Best straw yield :

Photographs

Sowing

Germination

Pre-emergence spray

Field after 1st irrigation

After one month
(Without pre-emergence spray)

After one month
(sprayed with pre-emergence herbicide)

Reference

(Anonymous, 2004) Fertilizer statistics 2003-04. The fertilizer association of India, New Delhi. P 1-273.

(Holt, J.S. and LeBaron, H.M. 1990) Significance and distribution of herbicide resistance. Weed Technology 4: 141-149.

(Ali R, Khalil SK, Raza SM, Khan H 2003) Effects of herbicides and row spacing on maize (*Zea mays* L.). Pakistan Journal of Weed Science Research 9: 171-178.

(Crafts, A.S. and Robbins, W.W. 1962) A text bodk and manual: Weed control. McGraw-Hill Book Company, Inc. USA pp 93-94.

(Tesfay, A. Amin, M. and Mulugeta, N. 2014) Management of Weeds in Maize (*Zea mays* L.) through Various Pre and Post Emergency Herbicides. 2(5) 2329-8863. Department of Food Processing Punjab (2013): "Production of Agriculture and Animal Sector 2012-13",

(Hasan, G., Tanveer, S., Ullah Khan, N. And Munir, M. 2010) Integrating cultivars with reduced herbicide rates for weed management in maize. Pakistan Journal of Botany. 42(3): 1923-1929.

(CHANNABASAVANNA A.C., SHRINIVAS C.S., RAJAKUMAR H. AND KITTURMATH M.S. 2015) Efficiency of tank mix application of atrazine 50 WP and pendimethalin 30 EC weedicides in maize. Karnataka J. Agric. Sci., 28(3): 327-330.

(Tahir M., Javed ,M., Tanveer,A., Nadeem,M., Wasaya,A., Bukhari, S.A.H., and Ur-Rehman1,J. 2009) Effect of Different Herbicides on Weeds, Growth and Yield of Spring Planted Maize (Zea mays L.). Pak. j. life soc. sci., 7(2): 168-174.

(E. Larbi, J. Ofosu-Anim, J. C. Norman, S. Anim-Okyere1 and F. Danso. 2013) Growth and yield of maize (Zea mays L.) in response to herbicide application in the coastal savannah ecozone of Ghana. Net Journal of Agricultural Science Vol. 1(3), pp. 81-86, ISSN: 2315-9766.

(Abdullahi S1. Gautam Ghosh1. And Joy Dawson1 April, 2016) Effect of Different Weed Control Methods on Growth and Yield of Maize (Zea Mays L.) Under Rainfed Condition in

Allahabad IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 9, Issue 4 Ver. II, (PP 44-47).

(**Ileana BOGDAN, P. GUS, T. RUSU, A. POP, Anisoara VAJU, Paula MORAR 2007**) RESEARCH CONCERNING WEED CONTROL IN MAIZE CROP, Cercetări Agronomice în Moldova, Anul XXXX, Vol. 1 (129).

Gomez, K.A. and A.A. Gomez, (1984) Statistical procedures for agricultural research (2 ed.). John wiley and sons, NewYork, 680p.